

# Engineering Students' Perceptions of Soft Skills, Industry Expectations, and Career Aspirations

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**Abstract:** Because of globalization and the rapid advancement of technology, researchers and employers agree that the 21st-century engineer must have a set of skills (e.g., teamwork, communication, and management) that were not emphasized in the past. In response, many universities have started to implement program changes in order to graduate well-rounded engineers. As an attempt to assess the gap between what universities are exposing their engineering students to and the requirements of the industry, this paper examines the perceptions of a sample of engineering students about the importance of various soft skills and how well their universities have prepared them in gaining the associated abilities. Students were also surveyed about their career aspirations in an attempt to determine whether these aspirations affect their perceptions. The results revealed that, although the students showed a significant understanding of the importance of soft skills, some of these perceptions can be attributed to their career aspirations. This finding implies that universities need to play a stronger role in strengthening students' nontechnical skills in specific areas such as oral communication skills. DOI: [10.1061/\(ASCE\)EI.1943-5541.0000247](https://doi.org/10.1061/(ASCE)EI.1943-5541.0000247). © 2015 American Society of Civil Engineers.

**Author keywords:** Engineering education; Soft skills; Career aspirations; Student perceptions; Program recommendations.

## Introduction

Although engineers might still be perceived as individual technical contributors, the nature of engineering work in the postindustrial world has significantly changed to require much more than the technical expertise gained in university and by experience. To succeed in their entry-level jobs, 21st-century engineers are expected by employers to possess a set of soft skills, including communication, teamwork, management, and entrepreneurial skills. To this end, ABET updated its engineering program's accreditation criteria at the end of the 20th century to include a set of professional or so-called soft skills in addition to the traditional technical or hard skills that help students become better prepared to face the challenges of the real business world. This update served as a major step toward bridging the gap between the skills that students are exposed to in their universities and the skills that employers expect their entry-level technical engineers to possess. As a result, many engineering programs have acknowledged the need to expose their engineering students to soft skills at the university level. However, the inclusion mechanism of these skills remains challenging because engineering faculty may find it difficult to balance the different curriculum demands they face (Siller et al. 2009).

Despite efforts to align their curricula with the new ABET requirements, engineering programs are still being criticized for emphasizing technical skills while paying insufficient attention to nontechnical skills (Gilleard and Gilleard 2002; Siller et al. 2009).

Using a quantitative research approach, this paper investigates the extent to which the gap between university offerings and industry expectations (Fig. 1) has been bridged through an examination of the degree of exposure and understanding of various soft skills by senior undergraduate students. Because the career aspirations of engineering students strongly contribute to student perceptions and industry expectations (Lang et al. 1999), they are also investigated and related to their perception of the importance of soft skills for the first time in the literature. To achieve this aim, the research team designed and conducted an electronic questionnaire that was sent to senior undergraduate engineering students from several prominent Lebanese universities. Analysis of the questionnaire responses allowed for testing a set of formulated hypotheses and developing recommendations for the improvement of engineering curricula.

The paper starts with a literature review on the need for soft skills in undergraduate engineering education and examines previous studies on engineering students' career aspirations. Then the problem statement and the aims of the research study are explained, followed by a detailed examination of the methodology used. The main section of the paper comprises an analysis of the research results, which includes hypothesis testing and factor analysis in addition to basic statistics. Finally, the paper concludes with a set of recommendations for engineering programs, some limitations of the research work, and directions for future research.

## Literature Review

The nature of engineering practice is continually changing as a result of the changing economic dynamics and the emergence of the need for global collaboration and communication. Although the 21st-century engineer is expected to be primarily a team player rather than an individual contributor, engineering programs still largely emphasize technical skills and underemphasize the needs of the modern business world (Beder 1999; Chan and Fishbein 2009; Galloway 2007; Gilleard and Gilleard 2002; Kirschenman 2011; Lang et al. 1999; Meier et al. 2000). This is true even for ABET accredited institutions, as shown by ABET evaluators'

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Note. This manuscript was submitted on October 1, 2013; approved on February 5, 2015; published online on April 1, 2015. Discussion period open until September 1, 2015; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Professional Issues in Engineering Education and Practice*, © ASCE, ISSN 1052-3928/04015005(12)/\$25.00.

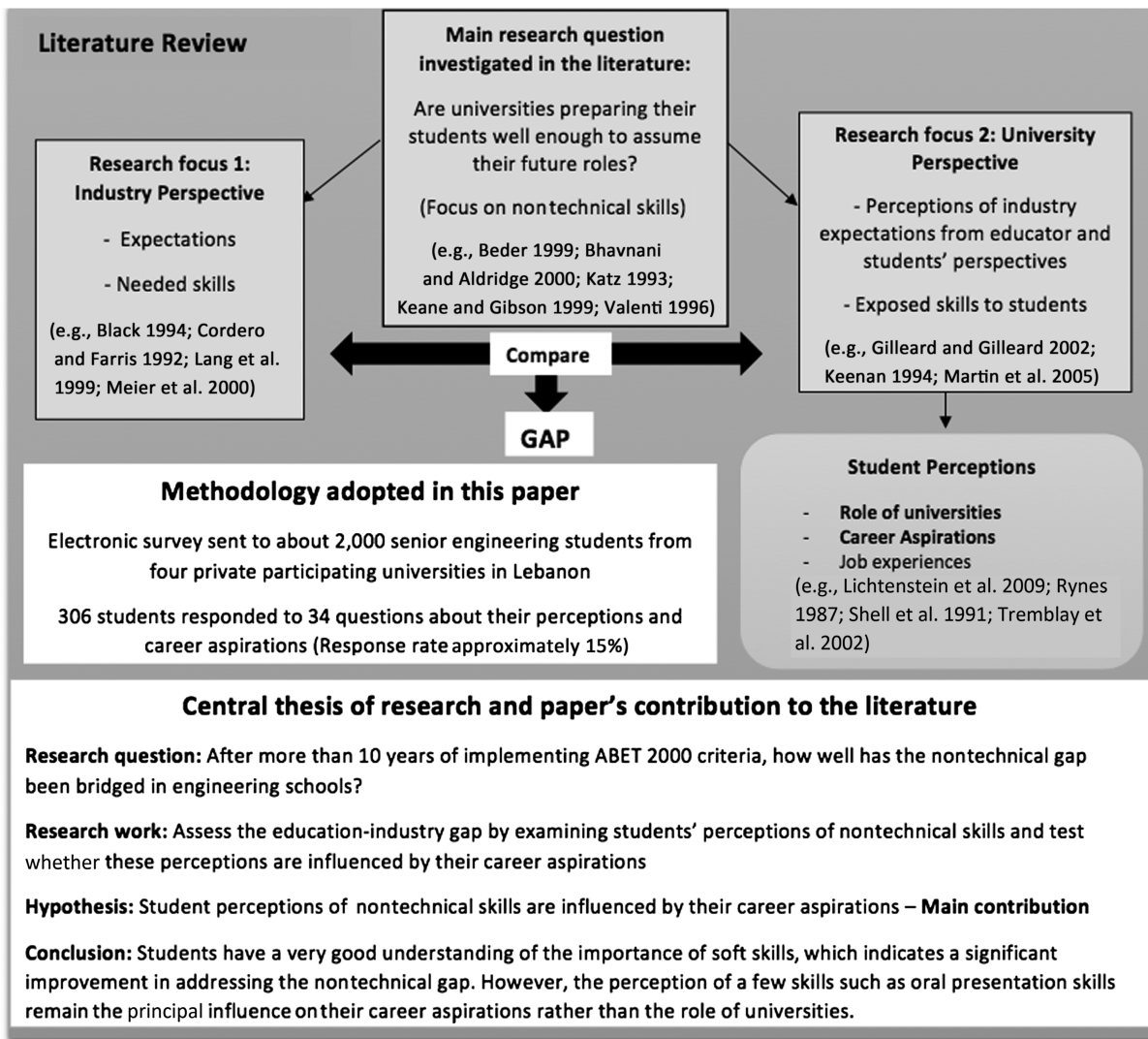


Fig. 1. Research framework

reports (Coe 2006). Since engineering education is considered to be the main agent of transforming students into practicing engineers, it must keep pace with the requirements of the engineering world and workplace.

### Need for Soft Skills

Several studies (e.g., Domal and Trevelyan 2009; Goh 2007; Katz 1993; Martin et al. 2005; Meier et al. 2000; Scott and Yates 2002; Valenti 1996) have recommended reform of engineering education by reporting on interviews and surveys with students, professors, graduate engineers, and employers, where a major gap between academic perceptions and industry expectations or employability skills for entry-level engineers was revealed. Employability skills can be defined as those skills that are needed by job applicants to secure a job, to keep that job, and do well in it (Robinson 2000). By examining the required engineering skills and attributes for engineering graduates at various accrediting institutions and countries (USA, UK, EU, AUS, and Japan), Zaharim et al. (2010) were able to show that many of the common employability skills for engineers consist of nontechnical skills, such as communication skills, teamwork, lifelong learning, professionalism, and decision-making skills. As reported by Katz (1993), engineering students have a narrow view of what their entry-level jobs involve and often

describe the positions as a learning experience. Students give higher importance to soft skills for skilled engineers than entry-level engineers (Lang et al. 1999).

Many universities have started incorporating into their programs, in tentative ways, the recommended soft skills while others, such as Purdue University, have considered wholesale reform plans for their engineering programs where two out of the three pillars, Abilities and Qualities, consist mainly of professional or nontechnical skills. This follows from the idea that the global engineer is no longer merely a technical person but a professional team player with high technical expertise (Redish and Smith 2008).

In the 21st century, good communication skills mandate cross-cultural experience and foreign language proficiency (Gilleard and Gilleard 2002). However, exposing students to multidisciplinary teams, as mentioned in ABET's criterion "d," remains one of the major issues at engineering schools (Coe 2006). In addition to the importance of communication in conducting global business, good communication skills are a requirement for successful leadership (Kirschenman 2011). Communication skills include oral communication with managers and peers, presentation skills, business writing skills, and cross-cultural communication abilities. All of these areas can be tackled at the undergraduate level if they are well integrated into engineering program curricula (Norback et al. 2009).

Due to calls for engineering education change, ASCE has developed a set of learning outcomes for future civil engineers and has made additions to the body of knowledge (BOK) required for licensure. The added BOK criteria stress nontechnical content related to management and leadership (Siller et al. 2009). As explained by Cordero and Farris (1992), management skills are not limited to managers. Even technical personnel who perform administrative tasks require management and leadership skills in carrying out their daily functions. Apart from performing administrative tasks, many engineers actually assume managerial positions later in their careers. Srour et al. (2013) highlight that engineers' transition from the technical to the management path can encounter many difficulties, one of which is derailment. Derailment can be described as not meeting management expectations mainly as a result of a lack of management skills (Shipper and Dillard 2000).

In an attempt to improve the soft skills of their students, Colorado State University (CSU) initiated its Professional Learning Institute (PLI), which emphasizes leadership skills, among others. To strengthen students' leadership skills, the institute teamed up with industry professionals to develop certain skills in students such as project management and time management, effective teamwork and conflict resolution, personal leadership, and organizational leadership (Siller et al. 2009). Many other renowned universities, such as Stanford, MIT, and Pennsylvania State University, have also realized the importance of entrepreneurial skills for engineering students and launched entrepreneurship minors or programs to benefit engineering students. Equipping students with entrepreneurial and intrapreneurial skills, in addition to emphasizing leadership, communication, and teamwork skills, enables engineering students to feel more confident and motivated to transform their innovative ideas into real businesses of their own or within their employer organizations (Menzies and Paradi 2002; Souitaris et al. 2007).

The following section examines the literature on engineering students' career aspirations and career paths, with special emphasis on nontechnical domains.

## Career Aspirations

According to Gerken (1993), determining graduating engineers' career aspirations would make career planning and placement more accurate and efficient. Additionally, the identification of these aspirations would benefit students since they would be able to better prepare for their desired careers when receiving the appropriate educational and extracurricular experiences from career planning and placement professionals (Gerken 1993).

Several studies (e.g., Lichtenstein et al. 2009; Keenan 1994; Rynes 1987; Souder 1983; Tremblay et al. 2002) investigated the career aspirations of engineering undergraduate students to show that not all engineers aspire to pursue a career in engineering for a variety of reasons. The implications of such studies urge, on the one hand, organizations to improve their promotion and reward systems in order to retain their engineers and, on the other hand, universities to improve their programs so that they increase their students' interests in pursuing an engineering career. This result supports further the importance of incorporating nontechnical skills in engineering curricula in order to provide graduate engineers with the necessary ingredients for success no matter which career path they choose to pursue.

Several recent and older studies have reported different numbers of students who want to pursue engineering or go into management or who were simply unsure of their career aspirations. While Badawy (1981) and Gerken (1993) state that around 40%

of engineers have the desire to, and eventually do, assume managerial responsibilities and positions, Lichtenstein et al. (2009) report that 44% of their surveyed students were unsure of their future career and only 14% did not wish to pursue engineering. On the other hand, Jones et al. (2010) found that first-year engineering students had more positive attitudes toward pursuing a career in engineering at the beginning of the year than at the end of it. Possible reasons for this, as pointed out by the authors, had to do with the design of the curriculum and course offerings (Jones et al. 2010).

Although several recommendations have been proposed for revamping engineering curricula, and some effort has been made in this direction, gaps still persist in engineering programs in most countries, as shown in recent studies (e.g., Dunsmore et al. 2011). The gaps that exist in the relevant literature, the need for further research, and the specific aim of this paper are explained in the following section.

## Problem Statement

As illustrated in Fig. 1, identifying the gap between the offerings of academic curricula and the requirements of the industry toward the end of the 20th century was an important step toward convincing engineering educators that there is a real need for educational reform. However, research efforts should not stop at this point but must rather follow up on this issue with universities and organizations to make sure that the important findings in the literature have been appropriately addressed and that graduate engineers are becoming better equipped for their entry-level jobs. Along these lines, the main objective of this paper is to investigate the extent to which the education–industry gap has been bridged in engineering schools by examining the degree of exposure to and understanding of these skills by senior undergraduate students while taking prominent engineering programs in Lebanon as a case study. The paper also explores the career aspirations of these students and tests for the first time in the literature whether these aspirations influence their understanding of, and exposure to, nontechnical skills such as communication, teamwork, management, and entrepreneurial skills. The specific aims of this paper are to (1) assess the extent to which the nontechnical gap is being addressed in engineering schools by examining engineering students' perceptions of soft skills, and (2) determine the relationship between the career aspirations of undergraduate engineering students and their perceptions.

The paper addresses the following research questions:

- Do undergraduate engineering students understand the requirements of the industry and the importance of soft skills as employability factors?
- Are students' perceptions influenced by their career aspirations? Do the undergraduate engineers that think of pursuing a nontechnical career in the future, such as management or entrepreneurship, value nontechnical courses and skills more than others who aspire to a technical career?

The importance of such studies lies in the need for continuously assessing the performance of academic programs versus industry expectations/requirements. Similarly, this study aims to propose a number of recommendations for improving the programs of the participating universities on the basis of the survey results. The number of students to be served is equal to at least the number of undergraduate engineering students in the participating universities, that is, on the scale of thousands of students. Upon investing in program improvements incorporating more soft skills, management, and entrepreneurial studies at the undergraduate level, universities will be contributing to a series of advancements on various levels:

- Universities will be able to attract more students to the various engineering programs owing to their diverse career aspirations.
- The engineering profession's status and its perception by the public will be enhanced.
- Engineering graduates will be better equipped to assume 21st-century entry-level jobs that require soft skills in addition to technical skills.
- Engineers' chances of succeeding in their transition to management will be enhanced by acquiring early on the skills necessary for their management positions.
- Organizations will have a greater pool of applicants with the proper exposure to management and entrepreneurial skills and require less training and investment.
- Engineers having the necessary entrepreneurial mindset and skills will be more willing to start up their own ventures and thus contribute to economic growth and development in Lebanon.

## Methodology

Based on a literature review, an anonymous questionnaire of 34 questions was designed to achieve the study objectives. All social research requirements mandated by the Institutional Review Board (IRB) (e.g., informed consent, freedom of responding) were taken into consideration. In addition to having a demographics section, the questionnaire included four sections about education information, choosing engineering as a degree, postgraduate plans and career aspirations, and perceptions of nontechnical skills and employability factors. The questionnaire is summarized in Table 1. In addition to closed (choosing a single answer or multiple answers from a list of options) and rating questions, the questionnaire included some open-ended questions that were limited to short answers in order to receive accurate information regarding differences among universities such as grade point average (GPA) and year of degree.

All the references used from the literature in devising the survey questions are shown in Table 1. The designers of the survey constituted a team of the American University of Beirut (AUB)'s Engineering faculty with a deep knowledge of the characteristics of the engineering degree and its graduates. Yet to avoid bias, the Faculty of Engineering and Architecture (FEA) career center and two faculty members from the business school were asked to validate the survey where they served as pilot testers and helped in validating the questions, especially in terms of internal and linguistic validity.

Four prominent universities in Lebanon participated in the survey and distributed it electronically to their students. These universities were AUB, Lebanese American University (LAU), Beirut Arab University (BAU), and Notre Dame University (NDU). Two of these universities have been accredited by ABET for their undergraduate engineering programs, and the other two are aligning their programs with ABET criteria and seek to apply for accreditation at a later time. Moreover, two of them offer minors in engineering management under the faculty of engineering. All of the participating universities offer general education courses and required electives on engineering management and ethics. The questionnaire was sent out after obtaining approval, via engineering dean offices or career centers, to the senior-level undergraduate engineering students. A senior student is defined as any student who is in his or her last 2 years of study. The sampling method used in the proposed study is referred to as *one-stage cluster sampling* since all students from different universities answered the same questionnaire, which was accessed using a single link over a period

of 4 months. In total, the survey was sent to slightly more than 2,000 senior engineering students from 4 universities, and 306 responses were received. Therefore, the response rate was around 15.3%. The number of responses is comparable to other studies in the literature, such as that by Rynes (1987), who presented the results of 284 respondents, Lichtenstein et al. (2009), who recruited 80 students in their study, and Gerken (1993), who surveyed 182 students.

After closing the questionnaire, it was necessary to subject the raw data to cleaning and filtering in order to facilitate the analysis. This was done using coding and categorization techniques on SPSS, IBM. Validation was also performed based on a descriptive statistical analysis.

Based on the literature review and primary analysis, a set of hypotheses stemming from the study objectives were formulated and tested. Inferential statistical methods, such as cross tabulation, T-testing, and factor analysis, were used to identify the validity of patterns and relationships among different variables and made it possible to either reject or not reject the hypotheses. The main hypothesis from which several hypotheses were derived is the following:

"Students who aspire to a management, nontechnical, or entrepreneurship career understand and value the importance of nontechnical skills more than students who aspire to a technical career."

## Results and Analysis

Of the 306 respondents, 234 provided complete responses to all questions, whereas 72 students provided partial responses, implying that they had at least responded to one question out of the 34 questions. Instead of ignoring the 72 incomplete responses, each question was examined individually and the incomplete or invalid answers for that specific question were excluded because the researchers saw no need to use statistical methods, such as interpolation, to deal with missing data. Therefore, the number of responses for each question was different. Owing to this variation, the results of the survey are reported in percentages instead of whole numbers.

To obtain a solid understanding of students' perceptions, the mean ratings of different factors were computed and analyzed. Since all rating questions were on a 1-to-5 scale, any mean above 3.5 was considered significant, whereas any mean below that number was considered insignificant. To obtain more meaning from the gathered data and to analyze the factors that influence students in various aspects of their education and career perceptions, a factor analysis was performed on several questions that required rating different choices. The method used was principal component analysis, and the rotation method was varimax with Kaiser normalization. To ensure the validity of the results, the Kaiser–Meyer–Olkin measure of sampling adequacy was continuously shown to be greater than 0.6 and Bartlett's test of sphericity to be significant (associated probability less than 0.05).

## Demographics

The majority of the respondents (82%) were in the 20–22 age bracket. This is the expected age for senior engineering students who have not repeated classes since 18 years of age is the average for starting the university degree in Lebanon. Only 3.5% of the respondents were less than 20 years old, and only 1% were more than 25 years old. These results demonstrate that the surveyed sample's age was indeed comprised of the target population, i.e., senior engineering students.

**Table 1.** Research Questionnaire and References Used

Survey section	Question number	Question	Response type	Reference
Demographics	1, 2	Age; gender	Single choice	—
	3, 4, 5, 6	Nationality(ies); primary country of childhood residence; occupation of parents	Short answer	—
	7, 8, 9, 10	University; bachelor major degree; current year of degree; cumulative average	Short answer	—
Education information	11, 12	Minor degree; engagement in extracurricular activities outside classroom hours	Single choice	Rynes (1987) (Question 12)
	13	Whether parents graduated as engineers	Single choice	Rynes (1987)
	14	Whether parents moved into management later on (skip if answer to Question 13 is no)	Rating; 1 = irrelevant, 5 = very relevant	Rynes (1987)
Choosing engineering as a degree	15	Reasons for choosing engineering as area of study	Rating; 1 = untrue and 5 = very true	Rynes (1987)
	16	Truth of different statements about engineers and engineering	Single choice	Rynes (1987)
	17	Career plans after graduation	Single choice	Lichtenstein et al. (2009)
Postgraduate plans and career aspirations	18, 19	Master's degree preference; best time to pursue master's degree	Single choice	Srour et al. (2013)
	20	Reasons for pursuing a master's degree	Multiple choices	Srour et al. (2013)
	21, 22	Preference between running own business and being employed by someone; best time for starting own business	Single choice	Souitaris et al. (2007)
Perceptions of nontechnical skills and industry expectations	23	Contribution of several factors to decision of selecting first job	Rating; 1 = unimportant, 5 = extremely important	—
	24, 25, 26, 27	First job preference; likelihood of selecting a job that is different from answer to Question 24 if an unexpected opportunity looked more promising; perceptions of first career choice; job in 20 years	Single choice	Lichtenstein et al. (2009) (Questions 25 and 26) Rynes (1987) (Question 27)
	28, 32, 34	Importance of offering of different courses/topics; role of different factors in employers' decision when selecting engineering graduates for entry-level positions; role of different factors in promoting engineers to higher positions in organization	Rating; 1 = unimportant and 5 = extremely important	Meier et al. (2000) (Question 34)
Question 28; willingness to enroll in courses outside engineering and science schools beyond academic requirements	29, 30	Accuracy of statements referring to courses listed in Question 28; willingness to enroll in courses outside engineering and science schools beyond academic requirements	Single choice	—
	31	Reason for Question 30 answer	Multiple choices	—
	33	Preparedness to handle different tasks as a result of university education	Rating; 1 = poor, 5 = very good	ABET (2011), Lang et al. (1999)

The gender distribution of the respondents was 20% females and 72% males. The remaining 8% did not wish to reveal their gender. These percentages are typical for engineering schools in Lebanon and other parts of the world (Baytiyeh 2012; Yoder 2011) and, thus, indicate that the sample represents the target population in terms of gender.

The surveyed students from the four participating universities consisted mainly of Lebanese students (90%). The remaining 10% were distributed over nationalities from the Middle East region. Almost one-fifth of the Lebanese respondents reported having a dual nationality, one-third of which had an American passport. Moreover, the majority of the surveyed students spent their childhood in Lebanon (84%), with the remaining having spent their childhood in other countries. These numbers reflect the demographic characteristics of the student body in Lebanon (AUB 2013).

### Education Information

After collecting all responses and closing the survey, the respondents were distributed as follows: AUB—66.2%; LAU—14.4%; BAU—12.0%; NDU—7.4%.

The responding students were distributed over several major degrees. A total of 35% were in a civil engineering program, 30% majored in electrical and computer engineering, and 24% were in mechanical engineering. It is notable that the majority of engineering students in Lebanon are distributed among these three majors since they are among the first majors that appeared in engineering schools in Lebanon. The rest were distributed over architectural, chemical, industrial, and construction engineering.

To verify the seniority of the responding students, they were asked to indicate their current year of degree. Table 2 shows the distribution of students over the four universities and proves once more that the sample is representative of the target population.

The responses to the question on cumulative average varied across schools that use a 100-point scale and schools that use a 4-point GPA scale. On average, students scored 80.47 on a 100-point scale and 3.11 on a 4-point GPA scale. The two figures are comparable to the statistics presenting the cumulative average of senior engineering students (AUB 2013).

The vast majority of respondents (60.9%) did not pursue a minor degree in addition to their major engineering degree. Among those who pursued a minor degree, 15.6% chose engineering management, 11.5% chose mathematics, and 2.5% chose a minor in business administration. The remaining respondents pursued minor degrees in different fields, for example, economics, philosophy, or physics. The choices of engineering management and mathematics as a minor degree are especially interesting. The results show that a large percentage of engineering students are becoming aware of the need to acquire management knowledge in their undergraduate

**Table 2.** Cross Tabulation of University and Current Year of Degree

Question 7. University	Q 9. current year of degree				Total
	No answer	3rd	4th	5th	
Not specified	36	6	11	10	63
AUB (4-year program)	8	<b>60</b>	<b>90</b>	3	161
BAU (5-year program)	1	0	<b>17</b>	<b>11</b>	29
LAU (5-year program)	0	0	<b>13</b>	<b>22</b>	35
NDU (5-year program)	0	0	<b>11</b>	<b>7</b>	18
Total	45	66	142	53	306

Note: Numbers under the senior years are put in bold font to show that the sample was indeed representative of the population; AUB = American University of Beirut; BAU = Beirut Arab University; LAU = Lebanese American University; NDU = Notre Dame University.

education, as highlighted in the literature review. However, almost an equal number are still willing to enroll in overload credits just to foster the mathematical knowledge and problem-solving skills that have been traditionally associated with engineering skills.

More than one-quarter of the responding students expressed an interest in engaging in extracurricular activities, although they did not think they had enough time to do so. On the other hand, 65.8% found the time and were engaged in a variety of activities, whereas only 8.3% were not interested in any kind of extracurricular activities. These results, although more positive than negative, suggest that some students who value this engagement in extracurricular activities still do not feel they have sufficient time to do so because of their degree obligations.

### Perceptions of Engineering

When asked why they chose engineering as their major field of study, students gave the highest mean rating, over 5, to nonemployment factors such as “Having high abilities in science and math” and “Enjoying solving engineering-type problems.” Other significant (average rating greater than 3.5) but lower mean ratings were given to employment factors, namely, “Ease of finding employment” and “Flexibility in changing careers.” Less significant (average mean less than 3.5) factors were attributed to family and teacher encouragement, being self-employed, rising up to management, and having an engineer in the family. This shows that students still choose engineering for the traditional reasons of being associated with high-level scientific abilities and good job opportunities.

When asked to rate the degree of truth of several statements about engineers and their jobs, the overall perception of engineering students seemed positive. In summary, all statements received a rating of 3.5 or higher, with the lowest being given to “Engineers are good communicators” and the highest to “Engineers are respected by employers and society.” Senior engineering students in Lebanon seem to have a positive image of engineers and their future profession. They believe that engineers can easily shift from technical to managerial positions, yet several students are aware of the lack of communication skills among engineers.

### Postgraduate Plans—Short-Term and Long-Term

When asked about their immediate plans after graduation, 16.4% of students were still undecided. This is a much lower percentage than the 44% of undecidedness revealed by the study of Lichtenstein et al. (2009). The majority (37.4%) were planning to start working and 27.7% were planning to work and pursue a master’s degree in parallel (37% planning to pursue a master’s in a management-related field and 37% in a technical field). Finally, 17.6% would like to pursue a master’s degree right away (64% in their technical domain), and one student explicitly expressed an interest in starting his own business. The results indicate that engineering students are aware of the market demand and intense competition for engineering jobs in Lebanon and the region. This is why almost half of them (45.3%) plan to pursue a master’s degree, and many of them (60%) prefer to have an MBA or a management-related degree.

When asked about their first job preference, around one-third of the respondents expressed their desire to assume a job having the title of Engineer and involving both technical and administrative tasks. Moreover, one-quarter desired to obtain a purely technical engineering job, while the rest almost equally preferred to be technical consultants or general or nontechnical consultants, fill a position involving management or supervisory training, or be part of a job rotation before settling on their first full-time position. Finally, around 9% were not sure what job they would want to have as their

**Table 3.** Cross Tabulation of Short-Term and Long-Term Career Plans

Question 24: If you had the chance to choose your first job, what would be your first choice?	Question 27: Where do you see yourself 20 years from now?							Total
	No answer	Not sure	Middle-level manager	Academic	Entrepreneur	General manager	Technical engineer or supervisor	
Not specified	69	1	0	2	2	0	0	74
Engineer in charge of mainly technical tasks (e.g., design, operations)	2	4	6	9	13	7	14	55
Engineer performing both technical and administrative tasks	1	3	10	3	27	21	6	71
General or nontechnical consultant	0	1	2	0	12	7	0	22
Consultant in the technical field	1	5	0	1	7	6	4	24
Not sure	0	5	2	4	3	5	1	20
Opportunity involving management or supervisory training	0	2	3	2	7	8	0	22
Other	0	0	0	1	0	0	0	1
Participant in a job rotation program (position will be determined at a later stage)	0	4	0	1	6	3	3	17
Total	73	25	23	23	77	57	28	306

first. In addition to their short-term career plans, students were asked about their long-term career plans. Because students may not have a good understanding of different roles such as middle-level manager, technical supervisor, and general manager, a full description of the role was provided in the choices. In summary, 10.7% of responding students were unsure about their career 20 years from the survey date. Around one-third of students expressed a desire to become entrepreneurs and manage their own businesses and resources. Around one-quarter wished to assume a general management position that had little to do with technical tasks. Still, 12% expressed a desire to continue in their technical domains and continue working as a technical engineer or a technical supervisor at most. The remaining 20% were equally distributed between desiring an academic position and taking a middle-management position, which involves supervising technical managers and requires some but not deep technical knowledge. Students' short-term and long-term career aspirations were also mapped together to better understand how engineering students thought about their career progression. The results of the cross tabulation are shown in Table 3.

The largest frequencies are shaded in gray and indicate the maximum concentration of responses. For example, one-quarter of students (i.e., 14) who desire a technical engineering position after graduation would still like to be in a technical position in 20 years' time, and another quarter (13 students) of this sample wish to become entrepreneurs. Moreover, 38% of students who would like to assume an engineering position involving both technical and administrative tasks after graduation would like to become entrepreneurs. Interestingly, more than half of engineers aspiring to a general or nontechnical consultancy position also wish to become entrepreneurs and run their own firms 20 years hence.

The most significant revelation that emerged from determining the career aspirations of senior engineering students was their considerable interest in being entrepreneurs, which unexpectedly exceeded their desire to be upper management.

To examine how sure students are about their first-job preferences, they were asked about the likelihood of selecting a different job from their original answer if an unexpected opportunity looked more promising. In summary, although more than 40% of the students seemed to be pretty sure of their first-job preference, around 60% were willing to accept another job based on external factors.

When asked their perceptions of their first job in light of their overall career, only 10% believed that their first job represented their lifetime career, whereas 34% said it was only a stepping stone

to their ultimate job. More than half of the respondents believed that their first job would be just one phase out of many transitions in their intended career. Again, these results reveal that most students are aware of the current trend of engineers to frequently change jobs and go through several career changes before settling into their ultimate career path (Srouf et al. 2013).

When asked about their employment preferences, students were divided almost equally among being employed in a large organization, being self-employed, and running their own business in parallel with being employed by someone else. Less than 10% showed a preference for being employed in a small to medium enterprise (SME) or in a family business.

When asked about the time at which they would consider starting their own business, only 2% of students showed a willingness to pursue entrepreneurship right after graduation, whereas 57% thought that they needed to gain sufficient work experience before doing so. These results give a good indication that students do not have enough confidence in their entrepreneurial abilities and skills, suggesting that universities might not be playing a sufficient role in providing graduate engineers with the necessary skills to launch their own ventures right after graduation.

### **Student Perceptions about Nontechnical Skills and Industry Expectations**

The last section of the questionnaire surveyed students about their perceptions regarding soft skills and employability factors from different viewpoints. All the responses showed on average a good understanding of the importance of soft skills at the university level (as offered courses) and in the workplace in terms of recruitment and promotion factors.

When asked about the importance of various course offerings associated with the learning of important soft skills, students considered all the courses listed in Table 4 to be very important, except for accounting and marketing courses. Moreover, when asked about the importance of various employability factors with respect to recruitment for entry-level positions, students rated all factors significant except extracurricular activities and physical appearance. This shows that they consider soft skills to be an important determinant in the recruitment process.

Three factors could be identified from students' responses to Question 32 (factors that contribute to the selection of engineering graduates at entry-level positions), as shown in Table 5. These factors can be summarized as personal attributes and nontechnical

**Table 4.** Perceptions of Students about Employment Factors and Importance of Nontechnical Courses

Factors	Mean rating
Question 28: Importance of course/skill	
Risk management	4.20
Project (or construction) management	4.17
Decision analysis	4.13
Sustainable development	4.10
Contemporary technological issues	4.01
Engineering economy	3.99
Engineering ethics	3.93
Entrepreneurship	3.89
Technical writing	3.83
Management theory	3.81
Basic accounting/finance	3.38
Basic marketing	3.27
Question 32: Importance of engineers' recruitment factors	
Education (reputation of degree and university)	4.43
Motivation and need for achievement	4.23
Teamwork and leadership skills	4.22
Relevance of education with applied position	4.05
Creativity and optimism	3.96
Communication and writing skills	3.90
Internship	3.83
Connections	3.81
Cumulative average (GPA)	3.72
Risk-taking propensity	3.57
Extracurricular activities	3.30
Gender and physical appearance	2.79

skills, education and educational performance, and identity and connections.

When asked to rate the degree of their preparedness as a result of their university education for doing a set of tasks, students rated all tasks listed in Table 6 as significant except for three: conducting an oral presentation, dealing with an ethical dilemma, and evaluating risk.

These results show that there is room for improvement in this area, especially since students have rated risk management as the most important course offering on the list in Table 4. Moreover, the literature review revealed the importance of oral presentation skills and ethical decision-making skills, which means that universities should devote more resources and effort to enhancing these skills. From a mean of 4.2 for the first factor and a mean of 3.7 for the last factor promoted at the workplace:

When asked to rate the different factors affecting engineers' promotion (Question 34), the mean of student ratings showed

significant numbers for all listed factors. The results showed that although engineering students still think of the ability to solve technical problems as the main factor influencing their success in the workplace, they also think of other nontechnical abilities such as management and leadership skills as well as communication skills to be significantly important. This is an indication that engineering students have started to understand that the workplace requires more than just being good on the technical side and that nontechnical skills are vital for real-world jobs, even technical ones.

Two factors could be identified from students' responses to Question 34 (Table 7). These factors can be summarized as broad thinking and nontechnical competencies and technical competence and dedication.

The factor analysis results can help career counselors at engineering schools to better approach students by knowing how students perceive employability skills and promotion skills. Knowing what students think of various factors regarding their future employment, career counselors would have an easier time planning their awareness sessions and transforming them into seminars that address different topics, depending on students' perceptions.

### Hypothesis Testing

Based on the responses to Question 24 (If you had the chance to choose your first job, what would be your first choice?), where students were asked to select their preferred job from among eight options, students were mapped into two groups, A and B. Group A included students who aspired to technical careers, such as being a technical consultant or an engineer in charge of technical tasks. Group B comprised students desiring more general careers involving nontechnical tasks such as managerial or administrative tasks. The mapping of the population was done according to Table 8.

To avoid possible inaccuracies in the results, two options from the choices in Question 24 were not included in the mapping. These choices were "Not sure" and "Participant in a job rotation program (position will be determined at a later stage)." The students choosing one of these options were excluded from the analysis because they were believed to be uncertain or undecided about their first job and thus could not be clearly mapped to either Group A or Group B.

The framework of Bradley et al. (1999) was followed in the verification of the hypotheses. To determine whether traits were significantly different among two different populations, a paired-sample t-test of equality of means was conducted to compare differences between Groups A and B. The test helped to identify significant differences that exist between the perceptions of students with technical career aspirations and nontechnical career

**Table 5.** Factor Analysis for Employability Skills and Attributes

Factor	Question 32: In your opinion, how do the following factors play a role in employers' decision when selecting engineering graduates for entry-level positions?	Component		
		1	2	3
Personal attributes and nontechnical skills	Creativity and optimism	0.811	—	—
	Teamwork and leadership skills	0.788	—	—
	Motivation and need for achievement	0.776	—	—
	Communication and writing skills	0.719	—	—
	Risk-taking propensity	0.694	—	—
	Extracurricular activities	0.528	—	—
Education and educational performance	Education (reputation of degree and university)	—	0.794	—
	Cumulative average (GPA)	—	0.793	—
	Relevance of education with applied position	—	0.672	—
	Internship(s)	—	0.456	—
Identity and connections	Gender and physical appearance	—	—	0.854
	Connections	—	—	0.733

**Table 6.** Perceptions of Students about Their University Preparedness to Perform Different Nontechnical Tasks

Question 33: Perception of university preparedness	Mean rating
Identifying and assessing engineering problems within realistic constraints such as economic, environmental, social, and safety factors	4.02
Leading a small team	3.95
Working effectively in a team	3.90
Dealing with people from different cultures and backgrounds	3.78
Writing a technical report	3.71
Performing research on emerging technologies and learning new techniques on your own	3.69
Recognizing and transforming opportunities for developing new technologies	3.62
Conducting an oral presentation in front of an audience	3.41
Dealing with an ethical dilemma	3.40
Evaluating potential risks and dealing with uncertainty	3.18

aspirations. The significance level for the two-tailed test was set at 0.05, and the null hypothesis was used:

$H_0: \mu_A = \mu_B$ ;  $H_1: \mu_A \neq \mu_B$  where  $\mu$  = mean;  $H_0$  = null hypothesis, whereby there is no significant difference between Groups A and B; and  $H_1$  = alternate hypothesis, whereby the mean ratings of Groups A and B are significantly different. If the results from the paired-sample  $t$ -test for equality of means showed that  $p < 0.05$ , then the null hypothesis was rejected.

Table 9 shows all the factors whose mean ratings differed significantly (designated by *sig*) between the two groups of student perceptions regarding the degree to which soft skills, employability factors, promotion, and others affect by their career aspirations. For example, Groups A and B showed no difference on the question of whether engineers made good managers; however, there was a difference in their belief about engineers' communication skills, as shown in Table 9, row 4. More specifically, Group B believed that engineers are good communicators, where students in Group A did not, as can be interpreted from the content of the *Significance* cell in Table 9 (Yes, B). It is notable that Group B rated all factors with significant differences more positively than Group A, except for one factor pertaining to Question 34, as shown toward the end of Table 9. Since this factor, engaging in self-development and continuous learning involving technical knowledge, refers to acquiring technical knowledge in order to get promoted, it is logical for the group of students that has technical aspirations (i.e., Group A) to favor this factor.

**Table 7.** Factor Analysis of Reasons Contributing to the Promotion of Engineers

Factor	Question 34: In your opinion, how do the following factors play a role in promoting engineers to higher positions in the organization?	Component	
		1	2
Broad thinking and nontechnical competencies	Having good oral communication and presentation skills	0.726	—
	Being customer-oriented	0.699	—
	Having a broad view of problems and seeing the big picture of the organization	0.689	—
	Showing strong abilities on supervising/managing others	0.684	—
	Being helpful and supportive with colleagues	0.649	—
	Recognizing and exploiting business development opportunities within the organization	0.643	—
	Having strong ethical conduct and behavior	0.635	—
Technical competence and dedication	Being on good terms with supervisors/top managers	0.580	—
	Practicing extended work involvement (e.g., working long hours, taking projects home)	—	0.807
	Engaging in self-development and continuous learning involving technical knowledge	—	0.757
	Being innovative and creative in finding solutions to technical problems	—	0.655

**Table 8.** Mapping for Hypothesis Testing

Question 24: Selected response	Group mapping
Engineer in charge of mainly technical tasks (e.g., design, operations)	A
Engineer performing both technical and administrative tasks	B
Consultant in technical field	A
General or nontechnical consultant	B
Opportunity involving management or supervisory training	B

Regarding their perceptions about the offering of nontechnical courses (Question 28) at the undergraduate level, Groups A and B differed significantly in their appreciation of the nontechnical electives not offered in the engineering school, namely, basic accounting/finance and basic marketing. There was also a significant difference among perceptions of management theory and project/construction management, although these courses are offered as graduate electives in the engineering school. These results might indicate that when engineering faculties offer certain courses in-house at the undergraduate level, the perceived role of such courses and their associated content is enhanced.

For Question 33, there was a significant difference in how well students from the two groups believed the university prepared them to conduct oral presentations in front of an audience. This difference can be attributed to the importance that students with differing career aspirations assign to this skill. Students who wish to pursue a nontechnical career might value this skill more than their counterparts and, therefore, might have devoted more effort to giving oral presentations during their university years since they knew they would have to engage in similar activities after graduation. Again in Question 34, there was a significant difference between how Groups A and B perceived the importance of oral communication and presentation skills in terms of the promotion of engineers to higher positions. These results indicate that those who aspire to technical careers do not appreciate the importance of oral communication and presentation skills, although employers emphasize such skills.

### Recommendations, Limitations, and Future Work

This paper contributes to the engineering education research field and practice by examining the extent to which the gap in nontechnical skills is being bridged in engineering programs by examining students' perceptions, linking them to their career aspirations, and recommending improvements.

**Table 9.** Hypothesis Testing Results

Choice	Sig
Question 16: In your opinion, how true are the following statements about engineers and engineering?	
Engineers can easily shift from technical positions to managerial positions	Yes, B
Engineers are good communicators	Yes, B
Engineers are good team players	No
Engineers make good managers	No
Question 28: What do you think of the offering of the following courses/topics?	
Engineering ethics	No
Technical writing	No
Engineering economy	No
Management theory	Yes, B
Project (or construction) management	Yes, B
Entrepreneurship	No
Basic marketing	Yes, B
Decision analysis	No
Risk management	No
Contemporary technological issues	No
Sustainable development	No
Question 32: In your opinion, how do the following factors play a role in employers' decision when selecting engineering graduates for entry-level positions?	
Education (reputation of degree and university)	No
Cumulative average (GPA)	No
Relevance of education with applied position	No
Internship(s)	No
Creativity and optimism	Yes, B
Risk-taking propensity	Yes, B
Communication and writing skills	No
Teamwork and leadership skills	No
Motivation and need for achievement	No
Connections	No
Gender and physical appearance	No
Extracurricular activities	Yes, B
Question 33: How well has your university education prepared you to handle the following aspects of your job?	
Applying knowledge of mathematics, science, and engineering	No
Identifying and assessing engineering problems within realistic constraints such as economic, environmental, social, and safety factors	No
Performing research on emerging technologies and learning new techniques on your own	No
Dealing with an ethical dilemma	No
Conducting an oral presentation in front of an audience	Yes, B
Leading a small team	No
Evaluating potential risks and dealing with uncertainty	No
Dealing with people from different cultures and backgrounds	No
Recognizing and transforming opportunities for developing new technologies	No
Writing a technical report	No
Working effectively in a team	No
Question 34: In your opinion, how do the following factors play a role in promoting engineers to higher positions in the organization?	
Being innovative and creative in finding solutions to technical problems	No
Practicing extended work involvement (e.g., working long hours, taking projects home)	No
Having a broad view of problems and seeing the big picture of the organization	No
Recognizing and exploiting business development opportunities within the organization	No
Having strong ethical conduct and behavior	No
Being customer-oriented	No
Being on good terms with supervisors/top managers	No
Engaging in self-development and continuous learning involving technical knowledge	Yes, A
Being helpful and supportive with colleagues	No
Showing strong abilities on supervising/managing others	No
Having good oral communication and presentation skills	Yes, B

Note: Sig = presence of a statistically significant difference.

### **Recommendations for Engineering Programs**

While the results of the research study are somehow positive, indicating that senior undergraduate students have a good understanding of the skills required by the industry, the hypothesis testing showed that some of the value that engineering students give to nontechnical skills is due to their career aspirations. When it comes to the importance of basic accounting and marketing courses that are not offered as electives in engineering schools, significant

differences were shown between the perceptions of students with technical career aspirations and others who have less technically oriented career goals. This indicates that engineering programs must still make more effort to explain to students, through courses, learning experiences, and career advising, the importance of gaining certain skills, especially soft skills, in the workplace. Moreover, engineering schools should start incorporating the development of important skills for entry-level jobs (e.g., management and leadership, cross-cultural or multidisciplinary communication) in their

courses. Those efforts do not negate the need to embed skills such as communication and teamwork in the majority of engineering courses instead of only in specific electives. This would ensure that students would acquire these skills and be able to use them later on.

A comparison of the present survey's results with those of similar previous studies reveals that students appear to have gained considerable awareness of the importance of soft skills in their engineering education. Universities have finally started to seriously address the needs of the industry and give more consideration to the set of nontechnical skills required for success in the workplace. Although students in Lebanon do appreciate the soft skills that are taught at the undergraduate level, the survey presented here showed that they focus on teamwork and written communication skills more than oral communication skills. This implies that additional effort will be required from engineering schools to pay more attention to this area and incorporate it throughout the curriculum.

One important finding relates to students' interest in entrepreneurship. Although a high percentage of students indicated a desire to be self-employed, very few were willing to start their own businesses right after graduation. This finding highlights the lack of attention devoted to this issue in Lebanese engineering programs, especially given that the Lebanese economy highly depends on SME businesses.

Although uncertainty in career plans was not overwhelming, the research results show that many students remain undecided regarding future career plans. This demonstrates that universities must play a more active role in providing career guidance to students by employing more career planning and placement professionals and personnel to help students formulate their career goals. Career planning should be embedded in the last 2 years of an undergraduate program and not remain optional for students.

### Limitations of Study and Extension for Future Work

One limitation of research studies examining students' career aspirations is that they capture the students' decisions at one moment in time, but these decisions might change significantly later on. Moreover, students' responses may seem to be more decided than reality. One reason for this is that many students do not have a proper understanding of different careers and what they involve (Lichtenstein et al. 2009). Another reason is that graduates are influenced by market demand and employer selection policies (Rynes 1987). Although not all graduates pursue their desired careers, Rynes (1987) states that it is important to investigate students' preferences at an early stage, such as at the university level, since there they are less influenced by external factors such as market and organizational conditions.

To address these limitations, this paper tried to capture students' current career aspirations and future career aspirations while stating the different choices in a clear language. Therefore, the questions did not rely on students' prior understanding of certain terminology or career types. Instead, the students were provided with a detailed description of different roles and were asked to choose from them.

Other limitations of the research study presented in this paper can be attributed to the use of an electronic questionnaire, which resulted in a fairly low response rate, making it hard to dig deeper into the responses to analyze the root causes of students' perceptions and whether any factors other than those listed in the questionnaire, for example, work experience, affected their responses. The last limitation also partially stems from the absence of qualitative analysis, which was not possible owing to the low response rate of students. Therefore, the results are not universally generalizable; however, it can be said with a high degree of certainty that

the results can be generalized to engineering students in private universities in Lebanon and in countries with similar education systems.

Although career planning is widely regarded as an essential function in the workplace, this process should start as early as the university level to direct the right graduates to the right jobs and avoid economic losses and career drift. Faculty need to overcome whatever difficulties they might have with integrating nontechnical concepts into their course materials and providing students with experiences that resemble what they will face in the workplace.

Given the high entrepreneurial drive shown by engineering students, this area will be further investigated in future studies to determine what is needed to foster entrepreneurship in students and motivate them to transform their innovative ideas into prosperous businesses upon graduation.

### Acknowledgments

This work would not have been possible without the support of the Center of Teaching and Learning (CTL) at AUB, the FEA Career Center, NDU Faculty of Engineering, BAU Faculty of Engineering, and LAU Faculty of Engineering.

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