



Women in engineering: A qualitative investigation of the contextual support and barriers to their career choice

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ABSTRACT

This study explores both past and current experiences of female engineering students. Women continue to be underrepresented in certain STEM (science, technology, engineering, and mathematics) fields in most countries. Using Social Cognitive Career Theory as a theoretical framework, 30 semi-structured interviews were conducted with female engineering students in Lebanon to better understand their decision-making processes and to shed light on their experiences. Results indicate that female engineers continue to face significant hurdles in both social and professional settings. Society, as represented by their extended family and friends, questioned their choices, and discrimination, including sexual harassment, continues to be an issue at work or internships. This study also emphasizes the power of human agency and the importance of the nuclear family, in that most participants discussed the extent of support that they received, and continue to receive, from their parents and siblings, in addition to their belief that they are responsible for their own choices.

Background

The topic of gender differences in education has received much attention over the years, mainly as the result of two interesting dynamics. First, the number of female college graduates now outnumbers the number of male graduates in many countries. Using data published by the U.S. Department of Education, Buchmann and DiPrete (2006) showed that the percentage of bachelor's degrees awarded to women now surpasses that awarded to men. An inspection of the 2015 data revealed that the result is also the same when Bachelor's, Master's and Doctoral degrees are considered (Snyder, Brey, & Dillow, 2016). Data published by the OECD in Organization for Economic Cooperation and Development (2012) clearly highlighted that this finding is not unique to the U.S. alone. Fig. 1 shows the percentage of tertiary qualifications awarded to women in some countries in 2009. The figure clearly shows that, in most of these countries, more than half of these qualifications are awarded to women.

These numbers, however, hide the second interesting dynamic, which is that, although women are entering and graduating from universities at much higher rates than before, most of them tend to gravitate away from certain fields. Fig. 2 shows the percentage of qualifications awarded to women by field of study. The figure clearly shows that women are overrepresented in education, the humanities, and

health while being underrepresented in engineering and computer science.

The above observations have led researchers to examine factors that affect women's occupational choices. Given the findings that no gender differences exist in mathematical abilities (Else-Quest, Hyde, & Linn, 2010; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg, Hyde, Petersen, & Linn, 2010), that there are disparities in female enrollment within the STEM fields themselves (Cheryan, Ziegler, Montoya, & Jiang, 2017), and that women who excelled in math tended to prefer careers in non-math-intensive fields (Ceci, Williams, & Barnett, 2009), researchers have acknowledged that wider environmental factors need to be taken into consideration (Cheryan et al., 2017).

One of the most used models that incorporates environmental factors to explain female career choices is Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994), which is rooted in Bandura's (1986) Social Cognitive Theory (SCT). SCT explains gender development in terms of triadic reciprocal causation among personal factors, behavioral patterns, and environmental events (Bussey & Bandura, 1999). The theory posits that individuals are neither controlled by their environment nor are they completely autonomous (Bandura, 2001). Instead, the relationship is viewed as being bidirectional, where the individual has the ability to determine which part of the potential environment will actually be experienced (Zimmerman, 1990) through

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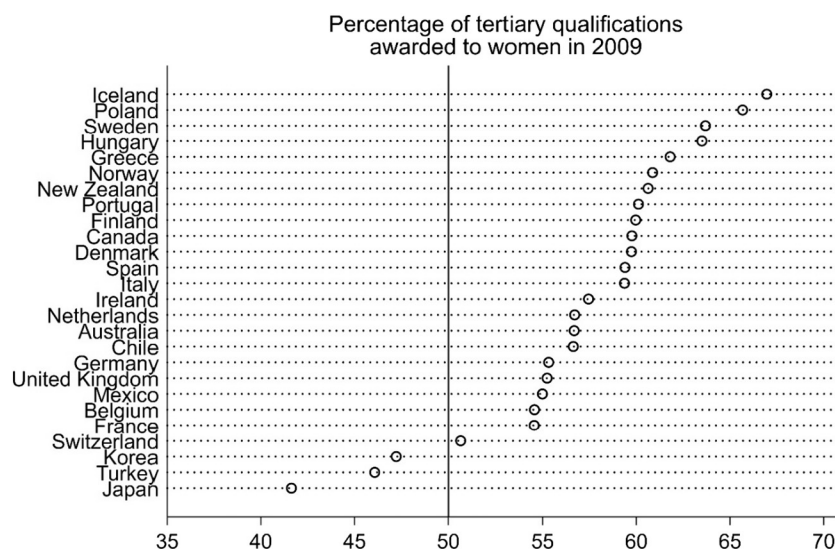


Fig. 1. Percentage of tertiary qualifications awarded to women in 2009 in some countries.

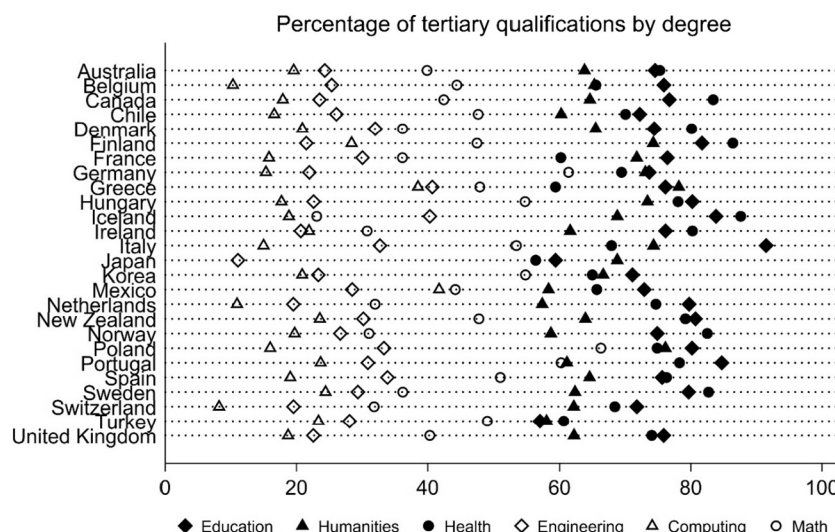


Fig. 2. Percentage of tertiary qualifications awarded to women by major in 2009 in some countries.

selection processes (Bandura, 1989). These selection processes in turn depend on the individual's self-efficacy since people avoid activities that they believe exceed their capabilities, even if the belief is not factual (Bandura, 1977). Perceived self-efficacy is formed from information gathered from direct experience in performing tasks, seeing similar others successfully perform tasks, social persuasion, and emotional arousal (Bandura, 1982).

Betz and Hackett (1981) found that female college students displayed lower levels of self-efficacy for occupations traditionally held by men, while male students displayed equivalent self-efficacy for occupations that were traditionally dominated by men and those traditionally dominated by women. As a result of this result, Lent et al. (1994) developed SCCT in an attempt to explain women's career choices, with the theory being mostly used to explain women's aversion to fields such as engineering.

SCCT has received strong empirical support (Fouad & Santana, 2017; Lent, Brown, & Larkin, 1987; Lent, Singley, Sheu, Schmidt, & Schmidt, 2007), but certain elements in it remain understudied. Fouad et al. (2010) note that most of the research using this framework focuses on individual cognitive variables as opposed to the interaction of these variables with environmental variables. This is indeed problematic given that SCT "subscribes to a model of emergent interactive

agency", in which individuals are "agents of experience, rather than simply undergoers of experiences" (Bandura, 2001). People do not only react to their environments. Instead, environments must be activated by human behavior (Zimmerman, 1990). Therefore, at the heart of this theory is the concept of human agency. Bandura (2001) argued that this behavior will be determined by the individual's self-efficacy, thus leading to the conclusions that perceived self-efficacy is the foundation of human agency and that self-efficacy is more critical than general outcome expectations (Zimmerman, 1990). The environment, however, continues to exert its influence because, without some degree of support, perceptions of self-efficacy cannot be sustained (Bandura, 1986).

As a result, Lent and his colleagues have called for incorporating contextual supports and barriers into SCCT (Lent et al., 2003; Lent, Brown, & Hackett, 2000). However, given that females choose not to enroll in engineering, and that many of those who do choose to study engineering end up leaving the field, recent studies have focused on contextual barriers (Fouad, Chang, Wan, & Singh, 2017; Singh et al., 2013) in order "to explain the gap between women's abilities and their achievements or to explain the inhibition of women's career aspirations" (Swanson & Woitke, 1997 p. 443). One of the few studies to investigate the difference between women who leave engineering and women who stay is the study conducted by Fouad, Singh, Cappaert,

Chang, and Wan (2016). Interestingly, the study did not find support for the hypothesis that women who leave engineering had experienced more barriers than those who stayed. The difference between the two groups was in the level of support that they perceived. This finding highlights the importance of incorporating contextual supports into future research. Recently, a study by Fernando, Cohen, and Duberley (2018) was explicitly designed to investigate the support structure available to women engineers in two companies in the U.K.

Purpose of this study

Research questions

The purpose of our research is to study the perceptions that successful female engineering students in Lebanon have with regards to their career choice, in terms of both contextual barriers and supports. This study does not seek to compare this group of students to females who choose not to enroll in engineering or to females who drop out of engineering at university level. Instead, this study seeks to understand the perception that these female students have about the barriers and supports in both their immediate environment as well as in the more general social environment. Of particular interest to our study is whether the participants perceive any barriers, and if so, what leads them to persist in this chosen path.

Empirical context

Lebanon has a population of around 6 million, of which almost half are female. According to the Global Gender Gap Report, the educational parity measure in the country is 0.959 (Leopold, Ratcheva, & Zahidi, 2016). The total number of students going to school in 2017 was 1,065,490, almost half (49.8%) being female (Center for Educational Research and Development, 2018). Out of the 200,807 students enrolled in university, more than half (56.91%) are female. Data published by the Center for Educational Research and Development (Fig. 3) clearly indicates that there are vast differences in enrolment rates in different majors, with males being overrepresented in engineering and females being overrepresented in fields such as education.

Methodology

Participants

We interviewed 30 female students currently studying at a university, 21 undergraduate students and nine graduate students. Seven out of the nine graduate students were studying civil engineering, one was studying biomedical engineering, and one was studying computer and communications engineering. The 21 undergraduate students were more diverse, with eight majoring in civil engineering, two majoring in mechatronics, six majoring in computer and communications engineering, and five majoring in biomedical engineering. All of the participants were Lebanese. Snowball sampling was used (Lindlof & Taylor, 2010) to select the participants. Initially, we started with participants who are students at the university where one of the authors teaches or who were high school classmates of the other authors. After the initial interviews, participants were asked to identify other potential participants who might be willing to participate in the research. None of the students approached to participate refused. All participants were eager to contribute to the research. All participants allowed for the use of their real first names even though they were informed that a pseudonym could be used. All participants were given a copy of the audio file of their respective interview and were told that they can request that certain parts not be included in the study and/or in the transcript. Only a single participant requested that a certain response be excluded.

The participants came from one public university and three private universities. As a result of the snowball sampling which was used, more than half of the participants were studying at the same university. Out of the 30 participants, 17 were studying at the same private university, nine were divided between the other two private universities, and four were studying in the public university. The study included students currently studying civil engineering, mechanical/mechatronics engineering, computer and communications engineering, and biomedical engineering. Participants were selected only if their cumulative GPA was at least 80% since the purpose of our study is to investigate the barriers and supports experienced by successful female engineering students. Only one participant was married. None of them had children.

Data collection

Semi-structured interviews because they allow researchers to explore subjective viewpoints (Bradford & Cullen, 2012), a crucial issue given that this study seeks to investigate the contextual barriers and

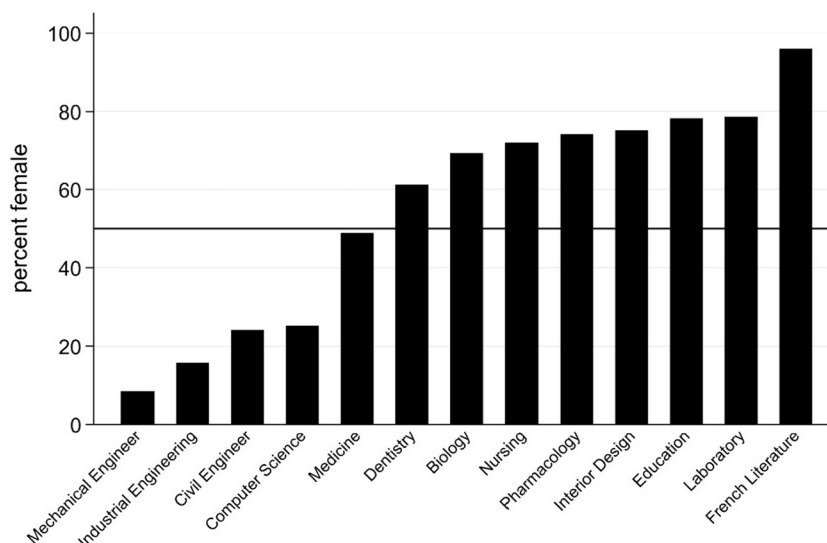


Fig. 3. Percent of female students in selected areas of study in universities in 2013 (data source: Center for Educational Research and Development (2014)).

supports as perceived by the participants. Semi-structured interviews can be used to investigate the participants' experiences and how these experiences might be informed by assumptions that exist in the wider society (Bradford & Cullen, 2012).

The interviews were conducted in locations that were suitable to the participants to ensure their comfort and cooperation. All of the participants were studying in institutes where the language of instruction was English, but we informed the participants that they could speak in either English or in Arabic, whichever was their first language. This ensured that participants were able to convey their thoughts as accurately as possible. All of the interviews were recorded and transcribed into English. The total recorded time was approximately 11 h and 20 min. The average length of each interview was around 24 min, with the longest being 45 min long and the shortest being 14 min. The document containing all of the transcribed interviews is 302 pages long and contains approximately 111,600 words.

Data analysis

The data was analyzed using a thematic approach because such an approach allows for the examination of the participants' perception of their environment, the meaning that they attach to the different aspects of their reality, and their social construction of these meanings (Braun & Clarke, 2006). This approach also allows us to study how these constructions reflect the social contexts in which the participants live and which constrain or enable their choices (Evans, 2018). The data was analyzed while taking into consideration the specific research questions. Therefore, not every piece of text was coded. Instead, the segments that were relevant to the research questions posed by this study were coded.

Initially, each of the authors coded the data for a single transcript separately. After that, the authors came together to compare, discuss, and modify the codes. After this initial exercise, two of us set out and coded the rest of the transcripts. In the next phase we worked together in order to examine how the codes fit into themes by examining similarities among the participants. By the end of this stage, the coded segments had been organized into broader themes that were of relevance to the research questions.

Results

The barriers

Extended family, friends, and society

We asked the participants about the reactions of the wider social circle when they told the people around them that they planned to study engineering. What we found was that, in the majority of cases, the extended family and friends of the family strongly opposed the idea even when close family members were supportive. Rachelle, for example, said that her mother wanted her to study something that would allow her to depend on herself as an adult. However, her aunts and uncles had a completely different opinion. She said that they strongly objected to her choice: "In their opinion, I am a girl, so I should get married soon and those sorts of things ... They said that engineering is demanding and that it will take time from my life."

Camelia had a similar experience as well. She talked about the reaction of the people in the village from which she comes: "They are not even registering the fact that I am studying engineering. To them, I will definitely change majors and start something else. They don't expect me to finish." Hiba was also another participant who blamed this state of affairs on people not seeming to understand what an engineer does. She also talked about people asking her whether she would pop the hood of the car and fix it, although she is studying civil engineering.

When Farah was asked about the reaction of her extended family, she said that the reaction was mixed but that she noticed that the older that people were the more opposed to the idea. She said that she was

irritated by these "provocative" questions and comments about her major. Khadijah and Rofaida spoke about how their uncles were very critical of their decisions to study engineering. Rofaida spoke extensively about her uncles' objections to her major, and she seemed bitter about the effect that they had on her father, given that he was very close to them,

My uncles ... even though I don't know how it is any of their business, but [smiling] ... they were like "engineering?" [sarcastically]. When I told them engineering, they first said, "OK, you can get a Ph.D. and teach as a doctor at a university." Then, I said, "Who said that I wanted to become a doctor?" Why do all people put me in such a position? Just because I want to do engineering, it means that I will teach. I tell them that I don't want to teach ... I tell them that, if I teach, I first want to gain experience in my field. I like to do practical work.

Not only did her uncles discourage her, but when her high school physics teacher heard that she wanted to become an engineer, his reaction was not what she had expected. Her teacher told her that engineering was difficult for girls because of the long working hours. He said that a career in education made more sense since she would have working hours that coincided with her children's school hours and she would also have a three-month vacation in the summer, causing her to comment, "Who said that I wanted a three-month vacation?"

Reem, who was encouraged to study engineering by both her parents and her extended family, says that she was also subjected to the same criticisms but by the people in her family's social circle: "Because they, in their heads, still think that a female should stay at home and do not like the idea of a girl studying engineering." Mira, who is studying computer and communications engineering, was supported by her parents, but heard many negative comments from other people,

Everyone was like "So you will sell telephones?" or "You will fix antennas?" or "You will fix our computers? You will know how to do this?" You know ... they have this idea ... they just know what they do, and they don't even try to get to know other domains. They don't try to find out what this person does and what that person does. For them, for example, a civil [engineer] means cement. And that's it. And communications for them is that you sell telephones and the things that they use in their daily lives. The mechanical engineer, or mechatronics, works under the car. You know?

Lana also said that there were negative comments from her extended family members, but that these comments disappeared over time when they realized that she would not change her mind. She heard from many of them that "females do not belong in civil engineering." Hiba also heard the same comment, i.e., that her field, which was also civil engineering, was not "for girls." Nour, another civil engineering student, was told that her engineering degree would end up being used to "decorate the wall." Hayat, whose father had wanted her to work in the family business, said that her grandmother was specifically hostile to the idea of her studying engineering – even more than her father. According to her grandmother, women end up taking care of their children, so if they want to work, a career in education fits them the most. In one instance, she heard her aunt ask her father whether it was worth it to pay such a large tuition for a girl to study engineering. Similarly, Yasmine talked about how people, specifically other women, told her that, in the end, she would "end up in the kitchen."

Ghida was another respondent who heard many negative comments about her choice, with people telling her to save the money instead of spending it on an engineering degree. She was also quick to note the importance of her parents' support throughout these experiences. She said that hearing all of these negative comments did depress her but that her parents' support helped her continue with the major,

However, at the end of the day, as long as it's something that you like, something that your father and mother support you in doing, it

stays something positive to you. Even if you feel down sometimes, you keep wanting it.

Dima also made a very similar comment:

It used to reach a point, when you keep hearing all those negative comments, that you would stop thinking about your goals and your aspirations for the future. Without my parents' pushing, I would've decided to leave or something.

The workplace

Engineering workplaces in the U.S. have been described as being hostile to women (Hewlett & Luce, 2007). As part of their studies, students are expected to complete an internship. We asked the students about their experience during their internships. Rachelle, a civil engineer, encountered considerable difficulty when she was working on site. She said that the only way for her to perform her job was to have a male engineer with her; otherwise, the workers would not listen to what she was saying. When asked whether she believed that women should not work on site, she said that it is not a place for women, not because women are lacking something, but rather because of how things are there, saying that the workers will “not listen.” She also talked about avoiding a certain male worker because of his “stares.” She lamented this situation because she said that the practical experience that she can gain on site is invaluable. Her love for her major extended to seeing the theories in action on site. If she loved the major, and on-site experience was essential, why would the solution to the problem be that women not go to the site in the first place? We asked her whether it was better to simply avoid sites or to go to them and fight to prove herself. She said that the ideal solution was to fight, but that it might not be practical.

Another civil engineer, Zeinab, also talked about the importance of on-site experience, but once again, she commented about some of the negative aspects of her experience working on site. She spoke at length about these aspects:

For example, the engineer used to tell me that, later on, as a female, the best thing for me was to work as a consultant, in an office; be an accountant in the office ... things like this, but not going to the sites. The site is a completely different world. The male engineers are exhausted there, let alone the female engineers. There is concrete, steel, and a thousand things ... it's not easy at all. You find that the salary of on-site engineers is higher than that of office engineers ... they really get exhausted. This is one thing. The engineer used to tell me that what was working in my favor was that my clothes are not revealing (she wears a hijab). If it was someone else, then it really wouldn't have worked out. Because there are employees ... you really feel strange at the site. For example, even he [the engineer] didn't let me go by myself to the site. He used to tell me that I can go with another engineer or with him ... other than that, he told me that I should stay in the office and work on the maps ... and help him with other things. You don't feel like yourself ... you feel that you are walking, but that all the workers are looking at you ... really ... there was this one guy who I used to go out of my way in order to avoid his stares. Really. I didn't go where he was.

Unlike Rachelle, however, Zeinab did not believe that the site is a place for women, not only because of the atmosphere but also because of the nature of the work. When asked whether she agreed with her supervisor's comment that he does not like her to go to the site, she said that working on site required significant physical effort and that “in my opinion, it is not something that is comfortable for a girl.”

Hiba, also a civil engineer, said that the site was not a place for a woman, although the experience she received there was important. She said that the physical exhaustion was too much to handle, for her at least. When we asked her whether she believed that there was a specific task that a female engineer on the site cannot accomplish, she said that all of the on-site tasks can be done by a woman as well as they are done

by a man.

Samia, a biomedical engineer, talked about her experience in her internship. There were only two interns, her and another woman, and all of the regular employees were men. When asked about how they were viewed, she laughed and said that they were “the weak ones,” although almost all of the men were technicians and not engineers like her and her friend. She performed her internship at a military hospital, where she says that there was considerable verbal and psychological harassment. She said that she was able to prove herself by acting tougher than she usually would. She also told us about a large confrontation that she had with one of her male workers when he continued making comments about how he would not even let his wife cross the street unless he knew where she was going. Another biomedical engineer, Yasmine, also recalled a story in which she was carrying a screwdriver and walking. She said that some of her colleagues sarcastically remarked, “You can unscrew a bolt?” Another biomedical engineer, Dima, said that when she was doing her internship some of her male colleagues told her,

Your future life and your children's ... biomedical engineering requires a large commitment, so someone's life is at stake. You might get called in at 3:00 AM that a machine has stopped working. You're forced to deal with reality.”

Rofaida, a computer and communications engineer, had completed two different internships. She talked about the difficulties that she faced during one of her internships with Middle East Airlines, the country's official airline. She worked in the IT department, and employees had to go from location to location solving various problems. She kept hearing from her male colleagues that women “don't like this type of work.” Ghina had also experienced differential treatment between male and female interns. She said that the male interns were asked to perform all sorts of work, while she was given a few sets of tasks to perform. Farah had not yet done her internship, but she told us about her friend's experience:

It was really annoying. On site, if you see what a female is wearing ... she would be wearing jeans, large boots, a helmet ... the safety material ... it's not really something to look at [smiling], yet they still look. This really annoys girls usually. If she is crossing the street, she gets bothered by this, so how about in her workplace?

Not all of the interviewees said that they faced difficulties during their internships. Reem, who was studying biomedical engineering, loved robotics. She said that she was approached by the supervisor of the robotics team at her university. The team was responsible for training high school students. The instructor responsible for the team approached her and asked her to join the team. He said that he was impressed by her knowledge of the subject. Her male colleagues on the team initially did not have the same reaction as their supervisor, but with time, she was able to prove herself to them.

Compromises between family and career

Lent et al. (2000) have argued that SCT differentiates between barriers along a temporal dimension. As a result, Lent (2013, p. 123) has noted that “career selection as an unfolding process with multiple influences and choice points.” When asked about whether they would have to compromise once they have families in terms of career choices, the participants' responses were divided into two categories: those who believed that they did not have to compromise and those who believed that they would have to compromise. However, the larger group was made up of those who believed that some compromise was necessary. A sizeable minority of the participants indicated that they were more than capable of handling both without compromising. Mira, for example, said that she is already multitasking now. She has a part-time job as a teacher, she studies at the university, and she goes to the gym on a regular basis: “Otherwise, you should have done something else.” When talking, she seemed to become increasingly agitated until she said that a

career was a form of security for women. She had seen it happen many times before: a girl gets married, has no career, and several years later is completely dependent on a husband, with whom she has a bad relationship. In Mira's view, if a woman sacrifices her career for her family, then she sacrifices her independence.

May found it strange that we would ask whether she would one day have to choose between her career and her family. To her, it made no sense to work so hard only to end up compromising: "I got educated to achieve something". Camelia and Dima also did not believe that they would have to choose. Camelia said that she could both be a good and caring mother and also pursue her dream of having a successful career, while Dima said, "If you can organize your life, you can do it."

When we asked Lana whether she would be able to manage her time, she simply said, "If someone other than me can do it, why can't I?" She said that she would rather have a full-time job than a part-time job but that, if she had to choose, then she would continue working, at least part time. To her, work was a form of extra security for the family. She wondered what would happen to their financial situation if, at some point, her husband lost his job and she were only a housewife with no or very little experience?

When asked about the topic, Farah and Rofaida were both more aggressive in their responses. Farah said that she becomes irritated when this issue is brought up because if she were a man, no one would ask her whether she would have to make a choice:

Because it provokes me. No, the girl is not like this. Just like a man has ambitions and dreams ... of course, they have a goal of having their own family like a girl ... why doesn't he ... why don't they put limits on him and tell him that his limit is to create a family. What makes him better?

Rofaida also raised the issue of the children being *her* responsibility: "Why is it my priority, but not my partner's priority? Why should I alone think about this?" Yara also expressed the same opinion:

He should know that we have been blessed with this child, and just as I am willing to sacrifice for them, you should be too. I can't even get along with someone who has a conservative mindset: "You're the female, so you take care of the children, and you clean the house." No.

The participants who held this view were not demeaning the work performed by stay-at-home mothers, as Kholoud explained:

It's not that I am undermining the role of the mother, the housewife, but we are at a time when we are getting an education. We are ambitious, and we want to work, so why would I drop my job if I have kids? I can balance both.

Some participants also said that they could manage both their family and career but that if they were forced to choose, then they would choose their careers. Rym was one of these people. She said that women should attempt to do both, but that if she had to choose, she would choose her career.

Most of the participants, however, believed that the day will come when they will have to come to some sort of compromise. The other participant, Farah, said that when the time comes, she will choose her family because, to her, family is her priority. When asked about the possibility of her husband giving up his job – if, for example, her job was better – she said that she would rather be the one to stay at home because "there are some things that the female can provide for the children that the male cannot." This view that a woman is better equipped to care for children was shared by Riham, who said that she would be willing to leave her job for a couple of years when she first has children as long as she returns to work eventually. Ghina also said that she expects to make some sacrifices but that they will never reach the point of causing her to leave work completely. She said that her work is essential for her self-worth.

The supports

Self-efficacy

We asked all of our interviews why they chose to study engineering. The answers that we heard from almost all of the interviewees could be classified into two groups. The first group wanted to study engineering because they loved the field and were curious to learn more about the subject. For example, Farah,¹ a civil engineer, said. "It's interesting ... When you cross a bridge, you might marvel at the structure. Don't you think, "How was this done?" Ghida, who was studying computer and communications engineering, said that she had loved computers since she was a little girl, and she was inspired by seeing her father's work. Mira, who was also studying computer and communication engineering, spoke passionately about her curiosity regarding the subject:

I was very curious ... I am studying computer and communications engineering ... so I wanted to know how signals are sent and even things such as what a computer is made of, how can telephones be that fast ... how can we transfer information in seconds, talk to someone in America. So, this all led me to pick this major.

Reem, who was studying biomedical engineering, said that she was fascinated by the machines used in hospitals to monitor people's health. This fascination led her to develop a curiosity for the subject. Yasmine, also a biomedical engineer, talked about her fascination with the medical field in general, and she said that it is what led her to choose biomedical engineering. Another participant, Ghina, was studying civil engineering because she liked transportation engineering, which was part of the major. She did not like the structural part of the major, and she was hoping that she could specialize in transportation engineering when she continues her master's degree and Ph.D.

The students in the second group wanted to challenge themselves. They believed that they were top students and wanted to study something in which not anyone could succeed. To them, engineering was a challenging major. When we asked them why they were studying engineering, many of them told us that they were thinking of either a medical degree or engineering, but for some reason or other, they ended up in engineering. For example, Jana, who is studying biomedical engineering, said that she wanted a field that was not stereotypical to "challenge myself and prove a point to society."

Bothaina, who was studying civil engineering, had originally intended to study medicine. She had a full scholarship to the American University of Beirut, the most expensive university in the country. She eventually ended up studying engineering because her father was not comfortable with her traveling a long distance to go to a university. Camelia, a mechatronics student, said that that she wanted to study the hardest major. She said that she believes that she is a smart person and therefore wanted to "go for the hardest major out there."

Another participant, Rofaida, was also conflicted about studying medicine or engineering. She said that she was thinking of becoming a medical examiner but eventually decided upon engineering. Zeinab, in contrast, had originally wanted to study media, but her parents objected because of the lack of job opportunities. They told her that business was a better choice. She applied to both the business school and the school of media and journalism. Her brother advised her to apply also to the school of engineering, which she did. She said that she planned to study the two majors, business and media, if she was accepted into them and to study engineering if she was accepted. She ended up being accepted into all of them and finally chose engineering.

Did the participants see themselves as trespassing on gender-specific roles given that studies in the U.S. (Faulkner, 2000; Frehill, 2004) and in Norway (Sørensen & Berg, 1987) have found that engineering is traditionally viewed as a masculine field? Of all of the participants, only

¹ There were two participants named Farah. One is studying civil engineering and the other is studying computer and communications engineering.

two believed that the field is better suited for men, but some of them indicated that there were certain tasks that they would rather not do. Alaa said that she loves to work with cement, to dirty herself, and to cut things. Does this statement mean that she views herself as masculine? She quickly responded “no.” She said that she is married and as much a woman as any other. She also said that there was nothing wrong with being feminine, as the concept is understood by society today, as long as it is within limits.

This view was also shared by Amal, who said that when a woman goes to a construction site, she cannot be too “delicate.” Does this mean that men make better engineers? The answer was no. Bothaina said that studying engineering caused her to change her mind. Previously, she believed that there were certain majors that were for men. Her experience in engineering has caused her to change her mind. She no longer believes that.

Camelia said that, throughout her university education, she was never exposed to a task that a man was able to do better only because he was male. Hiba told us that significant yelling and shouting occur on construction sites, which made her uncomfortable. When we asked her whether it meant that men were better suited for this type of work, she had an interesting take on the issue:

No. It is not even necessary to fight. If you see something wrong, you don't need to fight with someone ... When you act macho, the problem will just get bigger. I don't think that this male way of solving problems is good.

Mira went even further, stating that femininity gives her an advantage over men. When asked whether an engineer can be feminine, she said, “Definitely, and that's the amazing part. That's the amazing part.” Rofaida, who said that she was “boyish” when she was young, said that engineering requires a strong personality, which is not a masculine or a feminine thing.

Agency

The results of our research strongly indicate that agency plays a central role in the choices of these students. The majority of participants had very strong objections to the choices of women in general when it came to their university educations. This is not to say that they did not lay any of the blame on society as a whole, but our interviews clearly showed that the participants identified the mentality that women have as the primary culprit. Alaa, for example, talked about how her friends used to dream only of getting married.

Another civil engineer, Amal, also said that she blamed women for there not being more engineers. She said that if a woman wanted to work as an engineer, then she could. Camelia was even more critical and said that the state of affairs with the way that many women tend to think was “sad.” When asked about whether female students sometimes take the easy way in that they choose a relatively easy major that they could finish in three to four years instead of the four to five required for engineering, Farah said that, like most people, she looks forward to the point in her life when she can have her own family. However, it does not mean that it is her only life goal. She even went as far as saying that if she met the perfect knight in shining armor and he asked her to stay at home, she would leave him in a second.

I know that my parents worked very hard ... it wasn't easy for them to pay for this education for four years, to pay for university and school ... and they withstood, not just in terms on money, in terms of the stress that we go through. It is not just my decision. They have worked really hard. It's as if you just burn their money. No, this is not fair at all. In that case, don't send your girl to school.

Hayat, whose father wanted her to work with him in the family business instead of acquiring a university education, was also an example of respondents who lay the blame at the feet of women, even those facing social pressure. She said that women should not see themselves as having no hand in the matter: “At the end, who is making the decision?

It's her.” However, she did not ignore the negative role that society plays here, complaining, “Why is it just expected that the man should make ends meet?” Dima also talked about receiving much negative feedback, but choosing to persist in her major. She said that if one listens to the people around oneself, one will not get anywhere. Pascal agreed with the idea that if one listens to others one you will never achieve what they wanted:

Most importantly, it's the person's fault because if they don't challenge themselves and society and rip themselves away from that mentality and what people think and really put in their mind that this is what they love, they're going to spend their whole life doing something they don't like.

Yara also believed that society does not help women in this regard but that they, as women, “can't always blame other factors because if a girl has ambition and she knows what she wants, she can reach whatever she wants, no matter what.”

When asked about this topic, Mira was quick to blame women because they had no curiosity in such fields. They had no curiosity to “ask themselves, ‘What is this software that I am using on my computer, and how is it made?’” However, she also blamed the way that society portrays engineers. Whenever one sees engineers in advertisements and in television shows, they happen to be men:

I blame society because it puts this thought in people's head. If you look at all the advertisements, you will see that the males are the ones wearing the helmet that engineers wear and that they are fixing things and that they are writing programs on the computer, not females. This is one aspect. With regard to females, I blame them because there are other things that seem to grab their attention. They are not thinking about other things ... most of them want to become housewives. There is no effort ... They want the easy way.

Mira talked about how, through hard work, she was able to change how other students looked at her. She said that because she dressed in a feminine way, they would automatically underestimate her. However, “Once you prove them wrong ... that ... no ... you make them see.”

When Rachele was asked whose responsibility it was to encourage women to become engineers, she said that it was the educated people's responsibility. In her opinion, both educated women and men must take action to change these misconceptions. She also had some strong words with regard to the choices that women make:

I went to two companies where there were two senior engineers who were females, and they were fired. Why? Because they brought their home problems to work. You need to separate. You have to be strong. You need to show that you can achieve something, not that anything can affect you. Males also have personal problems. Why don't they show them while you show your problems? I blame females ...

She also talked about “choosing the easy way.” She said that most women in the Arab world are not willing to “really exhaust themselves to achieve something.” Jana also talked about how many women tend to follow the path of least resistance. Rofaida first started by blaming society; however, on her own, she started talking increasingly about the way that women view themselves: “One of the strange things is that these women themselves start applying the stereotype to themselves. Why are you underestimating yourself?” She was quick to note that society should not be an excuse.

We asked the participants to describe themselves in four words or phrases. The most frequent word was “ambitious”, followed by “stubborn” and then “confident”. These responses clearly indicate that the participants see themselves as active agents and not only as reactive elements.

While emphasizing the importance of the choices that women make and the power that they have over their destinies, the participants did not ignore the power that social surroundings have. Ghina noted that

her father had a positive effect on her. She said that had her father told her that going to the construction site was a job for a man, she would have probably not gone in the first place.

The field of possible choices

A few of the respondents laid the blame almost entirely on society. Rym and Farah were two of these people. They said that as long as companies have hiring policies that discriminate against women, an increasing number of women will question the logic of studying a difficult major only to be unemployed in the end. What was interesting is that, in many instances, when the participants were criticizing the state of affairs in society, they implicitly talked about the “field of possible choices” and that engineering as a major was misunderstood. SCCT distinguished between the potential environment and the environment that individuals actually experience (Bussey & Bandura, 1999). For an individual to make a certain choice, this choice must be in his or her field of possible choices. This is an important distinction because, when individuals make choices, they do not consider all of the options that are available to them. The individual is not aware of the existence of some options, or he or she might not have accurate information about these choices. Parents and teachers have effects on the options that exist for children, through encouragement (Eccles, 1994) and through the expansion of the pool of opportunities that allow for the development of domain-specific abilities (Wang, 2012).

We have already seen how some of the participants talked about being asked whether they would work “under the car” or “sell telephones” after earning their degrees. Yasmine, for example, said that she hesitated before enrolling in biomedical engineering because she thought that all engineers do is study physics. She said that she earned excellent grades in physics in high school but did not like the subject matter. She first joined the graphic design department, but after talking with a professor in biomedical engineering, she decided to switch: “I just took one physics course. That's it.” Rachele and Mira also talked about the need for society to understand “what engineering really is.”

The “field of possible choices” concept was also illustrated by most of the participants, indicating that the presence of engineers around them played an important role in their decisions. Mira said that her neighbor was a computer and communications engineer and that she talked to him before enrolling in the major. Alaa said that her father was an engineer and that she was very close to him and always participated in activities with him. In addition, Camelia and Ghida had fathers who were engineers as well, and they were encouraged by them. Farah and Rachele had older brothers who studied engineering, and they said that their brothers encouraged them to go into engineering. Jana said that her father had wanted to study engineering but was not able to do so due to the civil war. Ghina said that she used to watch her uncle, who was a civil engineer, work and that she liked what she saw. He encouraged her to study civil engineering, which is what she ended up doing. Zeinab and Jamila said that many individuals in their families had studied engineering as well and that they recommended it. In addition, Nour stated that her cousins, with whom she was close, were civil engineers, and she always used to see them at work. This experience also led her to choose civil engineering as a major. Similarly, Pascal had a brother-in-law who was studying computer and communications engineering. She said that he advised her to go into the field.

The parents

Researchers studying self-efficacy have documented how the parents' beliefs predicted their behavior towards their children, which in turn predicted the children's self-perception (Jacobs & Eccles, 1992; Simpkins, Fredricks, & Eccles, 2012). We asked the participants about their parents' reactions when they told them that they wanted to study engineering, a field traditionally associated with men. We found that, in the majority of cases, the parents were supportive, or at least they were not opposed to the idea. For example, Farah said that her parents were excited about the idea more than her because her elder sister had also

chosen to study the same major: computer and communications engineering. Alaa said that she loved her father greatly and was affected by him. He was a mechanical engineer. When asked about the activities that she engaged in as a child. She said,

I used to stay with my father; like, I wanted to learn how to drive a motorcycle – I wanted to learn how to drive a car. Since I was little, I was always on my father's lap, driving the car. I used to ... Once, I don't remember what grade I was in, but my father asked me, “What present do you want when you get your grades?”, and I said that I wanted a gun [laughing], and he got me a gun back then.

Ghida said that her father was very supportive since he was an engineer as well. Ghina also said that her father told her to study what she loves. Her mother, in contrast, wanted her to study mechanical engineering instead of computer and communications engineering. Jana said that her parents also supported her but that they warned her that it requires much work, with which she said that she was fine. She said that her father was excited about the idea of her studying engineering because he had wanted to study engineering but, as noted previously, was denied the opportunity due to the start of the Lebanese civil war. Her mother, however, was not very supportive because engineering was not for girls.

Riham was another student who was encouraged by her father but was advised by her mother, who had herself studied accounting, to study business. The participant May had a similar experience, with her father supporting her and her mother opposing the idea initially because she wanted her to study business like she had. Lana's father, conversely, neither encouraged nor discouraged his daughter. He told her to do what she wanted. The same applied to Rofaida, who was studying computer and communications engineering. She described his reaction as being “cool.” Samia said that her father was a translator, but he found the field of engineering interesting. Reem said that her father was very enthusiastic about the idea: “They supported me, and they started searching for universities that offered engineering. My mom and my dad and everybody – even my sisters.” Mira said that her parents are especially proud when they tell people that their daughter is studying engineering. She said that her parents did not care what major she chose as long as it was a competitive major.

Malak said that she was contemplating whether to study human resource management or engineering. When asked about her parents' opinion, she said that they told her that they supported her in either choice. Zeinab was also encouraged by both of her parents because they told her that engineering had better job opportunities than other majors did. Alaa said that her parents were very excited about the idea and that they had wanted her to travel to France to study there. She chose to stay in Lebanon, a decision that she says that she now regrets.

The participant Rachele said that her mother and brother played pivotal roles in her choice of major. Her father died when she was young, and it was important for her mother that she become as independent as possible. She said that her mother's experience in having to raise two children by herself taught her that she should concentrate on having a career. Her brother, who is also a civil engineer, also advised her to go into the major and later helped her during her internship.

These findings by no means indicate that all fathers were supportive. A small minority of the interviewees said that their fathers were not convinced by the choice of their major. Rym, who was studying civil engineering, said that her father had initially opposed the idea and preferred that she become a teacher so that she could be home early with her children. However, he eventually said, “Okay, go into engineering. It's not obligatory for you to stay with your children.”

Hayat, who was studying civil engineering, said that her father was not even enthusiastic about her finishing her university education. She said that he had his own successful business and that he had always wanted her to work with him in the family business, like her brothers. Camelia said that her father was also not very enthusiastic about her

major. She said that he wanted her and her sisters to go into education or “something like that”. When asked what “something like that” meant, she said, “Something that would lead to a comfortable life.” Although this was his initial reaction, Camelia says that her father became convinced that his daughters made the right choices and would later joke with them that he was a good role model. The above few examples notwithstanding, we generally found that the female students were supported by their parents.

Conclusion

In a study of Australian women who stay in engineering, Ayre, Mills, and Gill (2013) found that the women who they interviewed experienced isolation and marginalization in the masculine culture of engineering. Yet despite of this, the women continued to strongly believe in themselves as engineers. The present study reports similar findings in Lebanon in terms of the experience of students. The results of the interviews made it clear that female students who are currently succeeding in their studies perceive many obstacles. Many of the participants talked about being underestimated and, in some instances, their choice of major being ridiculed. Our study also highlights the finding that the interviewees are aware of the temporal dimension of their choices and the obstacles that arise as a result. None of the interviewees was surprised when we asked them about whether having a family in the future will be an obstacle to their career choice. They were all aware of the future barriers even though they had different opinions about how to overcome them.

Lent et al. (2000) proposed that the environment should be conceived as a series of embedded circles where the individual is surrounded by the immediate environment such as friends and the financial conditions, which is in turn encircled by the larger social context such as institutionalized practices. They theorize that the inner environment acts as a filter that alters the individual's perception of the larger environment. This framework is useful in explaining how different individuals have different perceptions of the options available to them. The interviews that we conducted revealed how the female students were exposed to engineering through family members thereby making the career choices one of the options available to them.

Our results also indicate how this framework can be used to understand the conceptual barriers and supports that female engineers experience. All of the interviewees experienced significant barriers in the larger social environment, but most of them also experienced strong support from their immediate context, specifically from their parents. While it has been hypothesized that women persist if they have support and that they leave if they face barriers, what we found was that the women who persist and succeed are confronted by a vast array of barriers but that these barriers seem to be confined to the larger environmental context. To overcome these barriers, the interviews seem to be relying on a combination of intrapersonal and inner environmental variables. The majority of female engineers whom we interviewed had strong belief in their abilities, a sense that they are responsible for their own decisions, as well as a very supportive inner environment. Further research is needed in order to investigate whether one of the differences between females who choose and persist in engineering and females who do not is in the inner environment.

Barriers to women engineers have been extensively studied in other countries. This study is the first, to our knowledge, to shed light on this problem in the Arab world. The findings clearly show that, similarly to other countries, female engineering students in Lebanon face significant hurdles that their male counterparts do not experience.

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Conflict of interest

The authors declare that they have no conflict of interest.

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