

PEER MENTORING IN ENGINEERING ENTREPRENEURSHIP: A LEARNING ENVIRONMENT FOR WOMEN STUDENTS

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Abstract – *Entrepreneurship in engineering is an intersection of two male-dominated domains and is particularly prone to a gender gap. Entrepreneurship education—the teaching of skills and cultivation of talents that students need to start businesses, identify opportunities, manage risk and innovate in the course of their careers—is now a staple in many universities across Canada and around the world. However, the participation of women in such entrepreneurial programs remains quite low. This paper presents the novel Women's Start-up Network program at the University of Ottawa. The objective of the program was to develop an entrepreneurial mind-set and competencies in female engineering and computer science students through facilitated peer mentorship training. Participants were surveyed to determine the degree to which a peer mentor-training program could increase participants' knowledge about entrepreneurship and influence participants' entrepreneurial self-efficacy and intentions. This paper reports on the preliminary results of the program and the implications for entrepreneurial learning and career intentions among female engineering students.*

Keywords: entrepreneurship, women in engineering, entrepreneurial intent, entrepreneurial self-efficacy, mentoring, peer mentoring, engineering education.

1. INTRODUCTION

Entrepreneurship in engineering is an intersection of two male-dominated domains and is particularly prone to a gender gap. Many universities across Canada have been working hard to increase the number of female engineering students and more recently Engineers Canada has set the bold goal of 30% women new licensees by 2030. Entrepreneurship education—the teaching of skills and cultivation of talents that students need to start businesses, identify opportunities, manage risk, and innovate in the course of their careers—is now a staple in many universities across Canada and around the world. However, the participation of women in such entrepreneurship programs remains quite low. For

example, at University of Ottawa, in the five year history of entrepreneurship competitions in the Faculty of Engineering, only once had a woman entered the competition. Although she won, participation of women did not improve.

Across the world, there is a persistent gap in women and men's entrepreneurial activity. The Global Entrepreneurship Monitor (GEM) reports that internationally women entrepreneurs have lower levels of Total Entrepreneurial Activity (TEA) and growth projections than their male counterparts [13]. While one might expect this gap to vary with the level of economic development of a country, there is no clear correlation [1]: developed countries do not demonstrate a higher level of participation of women in entrepreneurship. Narrowing to the technology sector, the gap becomes even more pronounced [12]. Even though more women are working in technology firms than ever before, few are leading technology startups.

Many rationales have been advanced to explain the lower participation rates of women including: a traditional masculine definition of “successful entrepreneur”, socio-cultural pressures to conform to traditional stereotypical female roles and a lack of access to financial and social capital [16,7,6,17]. Another explanation relates to self-efficacy, defined as person's belief in his or her capability to produce given attainments [2]. Applied to the domain of entrepreneurship the construct of “Entrepreneurial Self-Efficacy” (ESE) refers to an individual's belief in her ability to successfully launch a business venture. ESE has been recognized as an important precursor to new venture creations [3,22] and high ESE directly affects the development of entrepreneurial intentions (EI) and subsequent action [5]. However, there is mounting evidence that women have lower levels of ESE and lower EI than men; furthermore, they tend to be more strongly influenced by any “perceived skill deficiencies in the entrepreneurial realm” [20 p. 388].

One way to increase ESE is through training and education [21] and this effect may be stronger for women than for men. Wilson et al [20] found, for example, that entrepreneurial education for MBA students was related to increased ESE but education made more of a difference

for female students than it did for men. Another approach to increasing ESE is through mentoring. In their study of 360 novice entrepreneurs, St-Jean and Mathieu [19] found that mentoring had a direct effect on ESE, mediating the relationship between satisfaction and intention to stay in the profession; furthermore, St-Jean [18] found that mentoring “maximizes the learning” for novice entrepreneurs, primarily through career-related mentoring functions.

Peer mentoring in university settings was found to offer benefits to both mentors and mentees, according to Colvin and Ashman [8], as well as providing clearer communication, generating mutual trust and greater collaboration as compared to a traditional (hierarchical) mentoring relationship. In the case of women, research has shown that mentoring relationships are often difficult to come by, and even when they are available, they do not offer the same benefits as they do for men [11]. For example, in medium and large-sized organizations, women find it difficult to find traditional mentors due to the lack of women in senior leadership. A direct consequence is that women rely more on peer relationships for mentorships in organizations. Entrepreneurship, by definition, is better suited to a hands-on and informal approach as compared to a more structured training environment. This is where mentoring can play a positive role, peer mentoring in particular.

Mentoring can also help in the development of social capital, a key component of entrepreneurial success. Social capital is defined as the social assets - collective knowledge, connections, and relationships - that one develops over time [17]. Social capital empowers women in many ways, the most important being the development of meaningful business relationships, relationships that can be leveraged for economic advantage. These assets are built over time, through different means, and they help an entrepreneur develop competitive and economic value. Compared to males, females are often disadvantaged when it comes to building social capital due to a wide variety of reasons – low ESE, perceptions of engaging in entrepreneurial activities as predominantly a male endeavour, and having fewer contacts of a professional nature. As a result, they have a lesser chance of securing an early stage investment [4,3,6]. Typically women have much larger or denser networks; however the configuration of their networks does not always facilitate entrepreneurial success. For example, it has been found that women tend to have more family and friends in their networks compared to men [10] and this may hamper women from acquiring the critical professional advice that they require for enterprise growth [17]. It is important for an entrepreneur to understand the true value of her network, in order to derive the maximum benefit from her social capital. Here mentoring can play an important role – to provide critical technical knowledge, access to resources, and hands-on coaching, in addition to

psychosocial support.

Given this information, we hypothesized that a facilitated peer mentorship program in entrepreneurship would help to develop an entrepreneurial mind-set and competencies in female engineering and computer science students. Participants, both mentors and mentees, were surveyed to determine the degree to which a peer mentor-training program increased participants’ knowledge about entrepreneurship and influence participants’ entrepreneurial self-efficacy and intentions. This paper reports on the preliminary results of the program and the implications for entrepreneurial learning and career intentions among female engineering students.

2. THE PEER MENTORSHIP PROGRAM

The Peer Mentorship Program in Entrepreneurship, named the Women’s Startup Network, (WSN), is a pilot peer mentoring training program at the University of Ottawa for women engineering and computer science students. The program for the mentors consists of an eight week training program to educate the participants in entrepreneurship (e.g., idea generation, elevator pitches, business models, financing, sales and marketing) as well as mentorship (e.g., role of the mentor, expectations, building trust, communication and active listening, self-awareness). After eight weeks in the classroom, the mentors participate in a number of self-directed activities over the remaining eight weeks. They start developing an entrepreneurial venture, design a program website, extend their business network, and gather entrepreneurial resources across the city. This serves as preparation for phase two, when they serve as mentors for more junior engineering students during the academic year. Over an eight month period, the mentors then work with first-year and second-year female engineering and computer science students (mentees) to develop entrepreneurial ventures and enhance their entrepreneurial networks. The core purpose of the program is to engage women engineering and computers science students who are interested in entrepreneurship and develop their ESE and EI. As noted earlier, self-efficacy can be improved through training [9].

The three prime objectives of the program are:

1. To increase the entrepreneurial skills and knowledge of all participants and instill an entrepreneurial spirit;
2. To increase entrepreneurial self-efficacy, and consequently entrepreneurial intent;
3. To build the students’ social capital by establishing a community of like-minded women engineers who are interested in entrepreneurship and a broader set of entrepreneurial resources..

3. METHODOLOGY

To measure the effectiveness of the training program, formative and summative evaluation was conducted at three different stages of the program: for the mentors, data was collected at the beginning (T1), at the end of the training – both classroom and self-directed (T2), as well as at the end of the academic year-long mentorship program (T3). For the mentees, evaluation was conducted at the beginning of the program (T2) and at the end of their mentorship experience (T3).

Several methods were used for collecting data. An online survey questionnaire was administered to mentors to collect baseline data at the beginning of the program (T1) as well as at T2 and T3. The mentees were also surveyed for the same baseline data when they joined the program (T2) and at the end of the academic year (T3). Apart from demographic data, the participants were queried on their content knowledge (entrepreneurial and mentoring), their EI and ESE. Data was also collected on the program effectiveness and characteristics. The latter were primarily formative in nature, to measure the *reaction* level of evaluation [14], to gain feedback on the program so that it could be improved, and to assist with future program planning. As it was in its first year of operation, the program was considered to be a pilot program; and the program directors were seeking ideas for enhancing its impact and effectiveness. To this end, the participant mentors and mentees were evaluated in greater depth at the end of the program, to accurately measure the program's effectiveness and determine program characteristics which could be adapted to future iterations of the program.

Individual interviews were also conducted with both mentors and mentees at the end of the mentorship program (T3) to assess the overall effectiveness of the program and to identify areas for improvement. The interviews also provided an opportunity to supplement the quantitative data gathered through the online surveys. Interviewers were able to seek further understanding of the participants' experience in the WSN program and gather richer, contextual data to support/explain the participants' answers – both mentors and mentees - about ESE, EI and social capital.

4. RESULTS

4.1 Baseline Survey of Mentors (T1)

The purpose of the first online survey (T1) was to assess the mentors' level of content knowledge (entrepreneurship and mentoring) at the start of the training program. It also established a baseline in terms of their perceived levels of entrepreneurial self-efficacy (ESE), entrepreneurial intent (EI). Demographic data was also collected.

The demographic data revealed that only four out of twelve participants selected for the program were born in Canada. In total, the participants had their roots across nine countries. The participants were also asked about their parents' country of origin. For 11 out of 12 participants, their parents were not born in Canada. Although Canada is a country with people with diverse ethnic backgrounds, research has shown that there is a strong correlation between immigration and entrepreneurship [15].

Participants were asked to rate themselves on their perceived entrepreneurial abilities, in order to capture their *entrepreneurial self-efficacy*. Participants rated themselves lowest in two dimensions: "Planning" and "Implementing – Financial". The *Planning* phase is defined as the set of activities that help convert their idea into a feasible business plan. *Implementing – Financial* refers to their "financial literacy" - their perceptions of their ability to organize and manage finances of their startup.

In an effort to measure EI, participants were asked to rank their intention to be an entrepreneur and their intention to work for an organization (within the next five years) on a Likert scale of 1 to 5 (1 (very unlikely); 2 (somewhat unlikely), 3 (neither likely nor unlikely); 4 (somewhat likely); 5 (very likely)). The average scores for both questions were identical and slightly above the midpoint at 3.77/5 (neither likely nor unlikely) demonstrating that they are somewhat non-committal, but optimistic about their intention to work for an organization and to be an entrepreneur. The group also scored relatively well on their content knowledge of entrepreneurship and mentoring.

4.2 Surveys at the End of Mentor Training Component & Beginning of Mentorship Program (T2)

Two online surveys were conducted at this point to measure the key variables of interest with respect to mentors and mentees: entrepreneurial content knowledge, EI and ESE. The first was an online survey of mentors, to determine whether there had been any changes in these measures as a result of their participation in the training program. The second was a baseline survey with the mentees, to establish the "starting point" pre-participation in the program.

Mentors: In terms of their Entrepreneurial Intent, there was little change in the strength of the respondents' responses; however, there was a slight movement in a downward direction. That is, there was a tendency towards lower scores in the intention to be an entrepreneur and slightly higher scores in the intention to work for an organization. We believe that this may be due to increased exposure, through the program, to "what it

takes to be an entrepreneur". Without gathering further qualitative data at this point, we can only speculate that it could also be due to what other authors have referred to as "feasibility factors". In other words, other personal/professional factors that may have come into play but were not measured. Coincidentally, at this point, four mentors resigned from the program citing "lack of time" and "other academic commitments" associated with their schoolwork. In terms of ESE, the average scores remained at a similar level. The participants continued to report lower perceived levels of efficacy in their abilities to perform tasks associated with planning and financial management of their new ventures. This is not surprising, given that the curriculum did not emphasize these elements of startup.

Mentees: We also collected demographic data and measured baseline levels of EI and ESE for mentees who had joined the program. Similar to the mentors, the demographic data revealed that many of participants in the program were born outside of Canada (50%), as were their parents (75%). Also similar to the mentors, they reported a relatively noncommittal score on their EI, with average scores of 4/5 and 3.9/5 (somewhat likely) to "pursue a career as an entrepreneur" and "as an employee of an organization" in the next five years.

4.4 Survey at the End of the Mentorship Program: Participant Mentors (T3)

At the end of the year, all participants were surveyed about their perceived EI, ESE, entrepreneurship skills and knowledge and other elements of the program. Six of the seven mentors who responded to the survey indicated that they were very likely (3) or somewhat likely (3) to pursue a career as an entrepreneur in the next five years. Average EI scores on this aspect increased by 14% since the year before. In terms of ESE, there were 19 questions which were asked of all participants. When compared to responses from T1 and T2, there was an increase in average scores across all areas. The increase ranged from less than 1% in perceived self-efficacy (the ability to "read and interpret financial statements") to 40% increase (the ability to "estimate the amount of start-up funds and working capital necessary to start your business"). Refer to Table 1 for a comparison of average scores these time periods. Not surprisingly, the greatest change in perceived self-efficacy is related to those areas of the program where there was a great emphasis. The program had not put much emphasis in the area of financials.

Consistent with these ESE findings, the mentors scored highly in all areas where we tested their entrepreneurial knowledge except financial valuation. Overall, the mentors felt strongly that their entrepreneurship skills had improved over the year long program and that they had learned effectively in several

areas, including mentoring and negotiation. Their self-declared biggest areas of learning were varied: from entrepreneurship to networking to self-awareness. All of the mentors said they would recommend the program to others, although some were less enthusiastic. Challenges in the scheduling and the commitment of the mentees made the process less than ideal. Expectations were also felt to be unclear for some. All appreciated the facilitators' knowledge and found one-on-one time with them to be extremely effective.

Individual interviews were also conducted with the mentors, to gain a deeper understanding of their mentorship experience, what it meant to them as participants, their key learnings, and how the program can be improved for the future. Preliminary results from these interviews are very telling, providing insights into each of the three program objectives: entrepreneurial learning, increased ESE and EI, and social capital (a community of like-minded female engineers; expanded entrepreneurial network).

In the qualitative data analysis, several predominant themes emerged. First, the entrepreneurial learning experience was positive and influential. All felt that they had acquired the basic skills to "be an entrepreneur." For several mentors, though, the learning was transformative. As one mentor explained: the program "*has made me look at myself as an entrepreneur...how to think and how to start my own business...I think that is my main takeaway...the fact that this program has achieved that is a huge deal*". This touches on ESE and identity. This participant is now visualizing herself as a successful entrepreneur. Another expressed similar thoughts, describing how she now has an entrepreneurial mindset: "*It changed how I think. This type of competency you can use anywhere.*"

While the mentors credited the classroom sessions with providing them with a structured and consistent learning environment for content delivery, it was the development of their social capital that was critical. Having a *community of women entrepreneurs* to support their learning and development was valued by all mentors. And once the mentees joined the program, this increased the breadth and depth of the community. As one mentor explained: "*There was a lot of interaction. And I think that when it comes to this topic in particular, there is a lot learned in person, but especially during interaction.*" A second mentor described the importance of meeting like-minded engineers: "*It helped me know more about the women in engineering, even though they are not in my program. I enjoyed this aspect...Sometimes when I think of the idea of not 'fighting' alone – this is very important!*" Another component of their social capital was their broader professional network. Mentors agreed that there was a need to "practice" their classroom-based skills and develop their network outside the university setting. Throughout the remainder of the

program, they were “learning in action”, as they developed team-based ventures. One mentor described this as “*very scary...but good*”; another felt it was “*very good! We had to get out there and connect with a lot of people*”; a third valued this networking for the opportunity it gave her to develop her confidence and communication skills. As she described: “*Before I joined this program, my interpersonal was so...I would say, it’s not natural. It comes very frozen, like a frozen person talking with a stranger. Now it has changed*”.

Finally, the interviews shed light on the somewhat contradictory ratings of EI from the survey data. While all of the mentors reported that they “have what it takes to be an entrepreneur”, (strong ESE), they described a variety of different career plans/trajectories. All were interested in starting their own ventures (strong EI). However, *not necessarily in the next 5 years*. Three had 10 year plans: one to complete her P.Eng first; two others to work on their ventures part-time while accumulating experience and financing in a corporate environment. Another was interested in starting right away – using the momentum and university resources while she could.

4.5 Survey at the End of the Mentorship Program: Participant Mentees (T3)

At this time only four mentees have responded to the survey. Two of these are more experienced students with at least a Bachelor’s degree under their belt, while two are first year students. They indicated that they were very likely (3) or somewhat likely (1) to pursue a career as an entrepreneur in the next five years. They also believed (three out of four for most skills) that they could perform most of the entrepreneurial tasks that the mentors did (e.g. brainstorm a new idea, estimate customer demand, etc.). They were not confident in the financial area however. The rest of the responses were spotty and as such cannot be deemed significant. The mentees did however appreciate the effectiveness of participating in the entrepreneurship competitions in the Faculty.

Once again, the results of the interview data provided deeper insights into the survey responses. When asked about valuable learning, one mentee responded that she learned that there are “many women like me”. This helped her to envision reaching out to other women when support might be needed. As for the mentors, the theme of a *community of women entrepreneurs* was valued by the mentees. For another participant, learning about business plans, making connections to industry and building her team were key to the success of the program. For *entrepreneurial intent*, the responses indicated that these mentees were definitely moving forward with their ventures, although one was interested in more entrepreneurship and business management courses first. One said she is moving forward with her prototype and that “*this never would have happened without WSN and*

the various entrepreneurship competitions” she entered. In terms of ESE, the interviewed mentees strongly indicated that their confidence had gone up as a result of their participation in the program with words like “absolutely” and “definitely”. One even went so far as to say “*Yes, I feel like I can’t make a mistake!*”. In terms of social capital, interviewees were again emphatic about how WSN had “totally!” increased their network of like-minded entrepreneurial women.

5. CONCLUSION

Clearly the Women’s Startup Network peer mentorship program in entrepreneurship as implemented as a pilot program at the University of Ottawa has had a number of successes with its 12 mentors and 7 mentees. While the entrepreneurial knowledge was successfully transferred to the students through fairly formal classroom and hands-on training and business creation for the mentors, and through peer mentorship and hands-on business creation for the mentees, it was encouraging to know that the program was also successful in 1) increasing entrepreneurial intent (EI), 2) entrepreneurial self-efficacy (ESE) and 3) overall confidence and 4) providing social support and networking for women in the Faculty of Engineering and among women of entrepreneurial mindsets or leaning.

The loose club-like structure of the academic year-long mentorship program with the mentees was difficult to manage as no set classroom meeting time was built into the mentees’ schedules. Future offerings of the program will most likely need to be run as a course to ensure regular participation. However, many of the participants were sufficiently dedicated to “make things happen” as most entrepreneurs do. They also made effective use of the time with the facilitators (professors and networked entrepreneurship coaches).

The ventures the women created were often based around serving people and we observed much interest around social entrepreneurship. For example, one venture revolved around creating an e-business for local aboriginal artists. This venture developed further into a wearable technology initiative, which serves to attract K-12 participants to STEM fields of study. Others connected students at the university for fellowship and guidance as newcomers to Canada, or as pre-professionals wishing to get experience under the supervision of senior engineers while serving startups. Within the Faculty, several other events engaged many of our mentorship program participants, some of them even organized them: a Difference Makers session was led by one of our mentees where large groups of students joined to solve social problems like the integration of Syrian refugees into Canada. One of our entrepreneurship challenges was to design an inexpensive oxymeter for emergency medicine

in war-torn regions. Several women signed up for this competition and won.

Overall, the goal of increasing the participation of women in entrepreneurship competitions was reached: half the entries to our various competitions were from women and many were on winning teams.



Fig. 1. Gender Equity in A Recent Engineering Entrepreneurship Competition at University of Ottawa

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Table 1: Mentor ESE Scores: Pre and Post Mentorship Program

<i>Do you believe you can?...</i>	<i>Average mentor scores</i>		
	<i>Baseline (Pre Program)</i>	<i>Post Program</i>	<i>Percentage increase</i>
<i>1. Brainstorm (come up with) a new idea for a product or service</i>	4.15*	4.71	13.5%
<i>2. Identify the need for a new product or service</i>	4.53	4.86	7.02%
<i>3. Design a product or service that will satisfy customer needs and wants</i>	4.0	4.57	14.29%
<i>4. Estimate customer demand for a new product or service</i>	3.54	4.57	29.19%
<i>5. Determine a competitive price for a new product or service</i>	3.69	4.43	19.94%
<i>6. Estimate the amount of start-up funds and working capital necessary to start your business</i>	3.15	4.43	40.42%
<i>7. Design an effective marketing/advertising campaign for a new product or service</i>	3.92	4.29	9.24%
<i>8. Get others to identify with and believe in your vision and plans for a new business</i>	3.54	4.43	25.16%
<i>9. Network—i.e., make contact with and exchange information with others</i>	4.31	5.0	16.07%
<i>10. Clearly and concisely explain verbally/in writing your business idea in everyday terms</i>	4.08	4.57	12.13%
<i>11. Supervise employees</i>	4.62	4.86	5.24%
<i>12. Recruit and hire employees</i>	4.38	4.43	1.00%
<i>13. Delegate tasks and responsibilities to employees in your business</i>	4.54	4.86	7.02%
<i>14. Deal effectively with day-to-day problems and crises</i>	4.38	4.86	10.86%
<i>15. Inspire, encourage, and motivate your employees</i>	4.38	5.0	14.04%
<i>16. Train employees</i>	4.54	4.86	7.02%
<i>17. Organize and maintain the financial records of your business</i>	3.54	3.57	.93%
<i>18. Manage the financial assets of your business</i>	3.54	3.57	.93%
<i>19. Read and interpret financial statements</i>	3.69	3.71	.60%

* Scale: Definitely Not (1); Probably Not (2); Not Sure (3); Probably (4); Definitely (5)