The Implementation and Assessment of an I-Corps Site at a Southwestern University: Lessons Learned

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Rodney Boehm is the Director of Engineering Entrepreneurship and an Associate Professor of Practice in the Texas A&M University College of Engineering. He has broad industry experiences, including over 35 years in all aspects of the telecommunications industry (sales, marketing, manufacturing, business development, and technical design), the creation of a telecommunications standard (SONET - Synchronous Optical Network) for the fiber optics industry that is still in use internationally over 30 years later, a wide variety of business experiences in international companies, and startup experiences. This has helped him lead a very successful industry career.

Currently he is using his technical business experiences to develop and run entrepreneurial programs for the College of Entineering. These include Aggies Invent, TAMU iSITE, Invent for the Planet, Engineering Inc., and curricular classes. In addition, he mentors multiple entrepreneurial teams.

Formerly he was a Senior Vice President of Fujitsu Network Communications, headquartered in Richardson, Texas. With over 30 years of experience in telecommunications, Rodney was responsible for developing partnerships with leading network technology providers and driving marketing efforts for optical, access and data products developed by Fujitsu. Rodney was Chairman of the T1X1 Technical Sub-Committee (the organization responsible for SONET standardization) from 1990 through 1994. He has been active in SONET's National and International Standardization since 1985. In addition, Rodney has published numerous papers and presentations on SONET.

Rodney began his career with Fujitsu Network Communications in 1989 as the Director of Strategic Planning. He also held the positions of Director of Transport Product Planning, Vice President of Business Management, Senior Vice President of Sales Management, Senior Vice President of Manufacturing, and

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Abstract

In this paper, we presented program implementation and evaluation for an I-Corps Site focused solely on engineering undergraduate and graduate students in a large Southwestern public university. The program implementation component included program data associated with curriculum content and format, recruiting approach, and participant data from five cohorts. Due to the delayed employment of the assessment, the evaluation component included findings from two cohorts using pre- and post-quizzes on knowledge of entrepreneurship terms and pre- and post-surveys that captured changes in perceptions of entrepreneurship and customer interview. The results of this study indicated that while student interest on entrepreneurship remained constant, there were significant improvements of participants in three areas of self-efficacy: (a) entrepreneurship, (b) marketing and business planning, and (c) customer interview skills. Regarding practice of customer discovery skills through interviews, students identified four areas in which they desired additional improvement: (a) formulating the right question, (b) contact identification within the market, (c) guiding discussion for useful customer feedback, and (d) interview presence. This paper provides valuable information for institutions interested in pursuing an I-Corps Site grant and to those who already have a grant but are looking for additional ways to further enhance program impact on their campus.

I. Introduction

In today's global market economy, equipping engineering students with a broader set of skills associated with an entrepreneurial mindset will empower them to create value for the companies they join or their own startups [1] [2]. In recent years, institutions across the nation have been investing resources in developing maker spaces plus curricular and extracurricular programs to provide opportunities for students to acquire knowledge, skills, and pursue innovative ideas while still in college. In 2011, the National Science Foundation (NSF) [3] launched the Innovation Corps (I-Corps) program focused on accelerating economic and societal benefits of NSF funded research projects. Today, there are almost 100 institutions participating in the program with an I-Corps Site program on their campus. While each institution utilizes similar approaches, including an I-Corps team formation, knowledge and skills training, customer discovery and guidance from experienced entrepreneurs, each ecosystem is unique because the program outcomes are closely related to the entrepreneurial culture both on campus and also in the surrounding local community [4].

The foundational elements of the NSF I-Corps include the following [3]:

- I-Corps Curriculum: Hypothesis-driven business model discovery that focuses on "getting out of the building" for customer discovery.
- I-Corps Teams: Teams consisting of three primary members (i.e., technical lead, entrepreneurial lead, and the mentor) and participating in a seven-week program that provides training and financial support for exploration of the commercial potential of the team's innovation.

- I-Corps Sites: Programs implemented to provide I-Corps like training and limited funding to support the local ecosystem and those interested to become an I-Corps Team.
- I-Corps Nodes: A network of nine Nodes funded to work collaboratively across the US to build, utilize, and sustain a national innovation ecosystem.

Each Site is funded at $100K/year for up to three or five years, depending on the Site type. For our Site, $90K was allocated to support program participant travels for customer discovery and only $10K was allocated to support staff in each year. Therefore, while the grant support is generous, it provides limited support for the staff running the program and for that reason Site implementation programs are successful only when they can leverage institutional resources available towards the entrepreneurial ecosystem. While each institution utilizes similar approaches on the Site implementation, including an I-Corps team formation, knowledge and skills training, customer discovery and guidance from experienced entrepreneurs, each campus has its own unique innovation ecosystem and that of the surrounding community which must be considered for successful Site outcomes. Furthermore, the challenges faced by each institution also depend on the group targeted by the Site grant. Some sites target faculty and their graduate students/postdocs while others, like ours, focus on graduate and undergraduate students. In addition, some Sites are open to all majors while others, like ours, while it is open to all majors, it is targeting engineering students. All these factors add additional challenges to be overcome by each Site.

The purpose of this paper is (a) to share the practice of the Site implementation for the past two years along with the entrepreneurship ecosystem at a Southwestern public research university and (b) to present the preliminary findings about the effects of the Site program on students' knowledge, perceptions, and practice through formative assessments for the past one year.

A. Entrepreneurship Program and the Ecosystem at the Southwestern University

In the past four years, the College of Engineering at a Southwestern university has made significant efforts to provide engineering undergraduates with opportunities to pursue innovation and entrepreneurship through programs focusing on developing a concept, creating a solution of value, and then developing commercialization plans. These efforts include: (1) facilities such as the 60,000 sq. ft. Maker Space, (2) extracurricular programs, such as Intensive Design Experiences (IDE), Pop-Up Classes, Business Management Certificate, and Lean Startup Program, and (3) courses with focus on entrepreneurship both at the college level and within departments. Engineering Entrepreneurship program provides engineering students well-defined pathways to develop entrepreneurial mindsets through immersive experiences in curricular and extracurricular programs. This will prepare students for successful careers as leaders of technological innovation within large corporations or launching their own startups. It involves developing programs in four unique phases covering the design and creation space as shown in Figure 1.

- Spark – Generating the idea and creating excitement that result from solving a significant problem for society
- Discover – Validating, through customer discovery, just how important the idea/product/service is to the market
- Prepare – Discovering the skills needed to deliver this solution through training, networking, and interacting with mentors
- Launch – Working with potential investors to create the business needed to generate revenue and profits as the business prospers

Figure 1. Four phases of the design and creation space

Every student involved in Engineering Entrepreneurship might not launch their own business, but each student engaging with us will benefit from skill development that will create tremendous value for their future employer. Specific skills include:

- Customer Value Creation
- Communication
- Multidisciplinary High Performance Teamwork
- Basic Business Knowledge (i.e., Balance Sheets, P&L Statements, Margin, Cost of Goods Sold, etc.)
- Basic Business Law (i.e., Contracts, IP, etc.)

Overall, the program has attracted more I-Corps Site teams in the second year and expect a much larger growth in the upcoming years due to closer ties to Engineering Entrepreneurship and significant changes on campus, which further promote entrepreneurship among engineering students. These include the following: the Concept, Creation, and Commercialization Certificate, Incubator, and the new building solely dedicated to engineering education.

The Concept, Creation, and Commercialization Certificate provides students with the training and experience to develop their ideas, create/design solutions to solve customer needs, and to understand the process of commercializing developed solutions. The program is focused on developing an entrepreneurial mindset, which will be valuable to the students as employees of companies or as creators of their own startup. The following courses have been developed to support the new certificate:

- Course 1 – Engineering Entrepreneurship Hour
- Course 2 – Product Lean Startup for Engineers
- Course 3 – Enterprise Basics for Technical Entrepreneurs
- Course 4– Sales, Operations, and Manufacturing for Technology Companies
- Course 5 – Technology Company Management, Leadership, and Corporate Culture

An Incubator was designed specifically for students in the College of Engineering. It has identified students' need for development resources, teammates, and business acumen, and provides pathways for each. Its goal is to connect with the inherent passion within entrepreneurial students and enable them to go from their idea to their business. Currently, there are 15 teams enrolled in the incubator and several of them are students who participated in past Site programs. As an example, a graduate student who participated in the Site program and is currently playing a leading role in further developing the incubator to meet student needs.

A new building with more than 500,000 square feet dedicated to engineering education, which includes collaborative space, conference rooms, video production facilities, and a 60,000 square feet maker space dedicated to undergraduates across the College of Engineering to support development of innovative designs and prototypes.

B. Site Implementation and Evaluation

Initial Approach. The Site program has become an important addition to the overall Engineering Entrepreneurship program for the College of Engineering. It fits in with the Discover phase where students determine the product market fit using the Lean Startup Method [5] and the Business Model Canvas [6]. The first two Site cohorts followed a six-week, weekly or bi-weekly meeting using traditional teaching methods that started with development of a value proposition, identifying target customer segments, developing hypotheses to test, and performing 30 customer interviews to determine validate or invalidate each hypothesis. Instruction was provided in how to develop a hypothesis, identify contacts, how to prepare, and how to conduct interviews. Students performed an initial in-class interview of peers and then conducted a "safe" interview of a person known to them. This was to complete initial interviews for practice that would enable more productive interviews earlier in the process. Students were provided mentors and gave presentations covering 5, 15, and 30 interview results. The final presentation was a culmination of the results of the program and each team gave a GO/NO-GO determination based on their customer feedback and product market fit.

Informal discussions were held after each cohort to determine how the Site program could be improved which was then implemented in the following cohorts. In addition, the PI and Co-PI identified potential improvements in recruiting teams, the length of the Site program, and curricular changes.

Current Approach. After the first two cohorts, we identified several areas for improvement to further maximize the impact of the program on our campus.

- Value Proposition: Since our entrepreneurship ecosystem is rather young, we had to further develop our message to students and the value the program provides to them. This includes regular emails, videos about past participants, and social media.
- Team Recruitment: To increase the number of teams applying to the program, we had to reach out to additional groups, such as capstone design faculty and individual faculty.
- Schedule: During an academic semester, it is very challenging for students to commit to a six-week program. For that reason, changes were made to the schedule to make it easier for students to participate while taking a full academic load. As an example, participants

were allowed to access travel funds up to four months after the completion of the six-week training.
- Incentives: Teams that met all program requirements were awarded I-Corps Site Fellows - College of Engineering Recognition.

Informal feedback was helpful in determining ways to improve the Site program, but a more formal method of assessing impact was needed. The PI and Co-PI added a member with expertise in psychometrics and program evaluation to our team to develop a formal assessment. During the third cohort, a post-pilot assessment was performed to determine the evaluation model used for the future cohorts. The pilot was successful and provided insight, which allowed us to finalize the instrument with an IRB approval and start using it with Cohort 4.

The Cohort 4 implemented the bi-weekly summer meetings for the full 6 weeks and implemented a more structured teaching team and mentor assignment. Students were provided instructions for value proposition development, presentation skills, market assessment, interview skills, and product market fit determination and each team was required to complete 30 customer interviews and provide presentations after 5, 15, and 30 interviews. At program conclusion, teams presented their final findings and included a GO/NO-GO determination.

The Site program was changed for Cohort 5 to reduce the formal meetings to five weekly meetings with only two instructional periods and three presentations from the teams. It was hoped that this reduction would be of interest to more teams as it dramatically reduced the formal meetings required. As a result, we attracted the most applicants for Cohort 5 and fourteen teams completed the Cohort program. Additional changes included implementing one on one meetings in the weeks where no formal meeting was held, condensing the instruction, and performing mock interviews with Professors of the Practice. After Cohort 5, the PI and Co-PI determined that this reduction went too far and did not require teams to provide enough deliverables to keep work on track. For that reason, Cohort 6 will include additional meetings and presentations. The assessment will inform if this change results in the positive effects as desired.

Overall, our Site program just completed two years with forty-eight teams participating in Cohorts 1 to 5 and representing a total of eighty-three students (37% females, 16% ethnic minorities) from across all engineering majors and freshman to graduate students, as shown in Figure 2. As of spring 2019, Cohort 6 is ongoing. It is worth mentioning that female representation is higher than that of the College of Engineering. Since program participants represent a diverse group and also a wide range of educational levels graduate, we plan to evaluate program impact also with respect to gender, race/ethnicity, and classification.

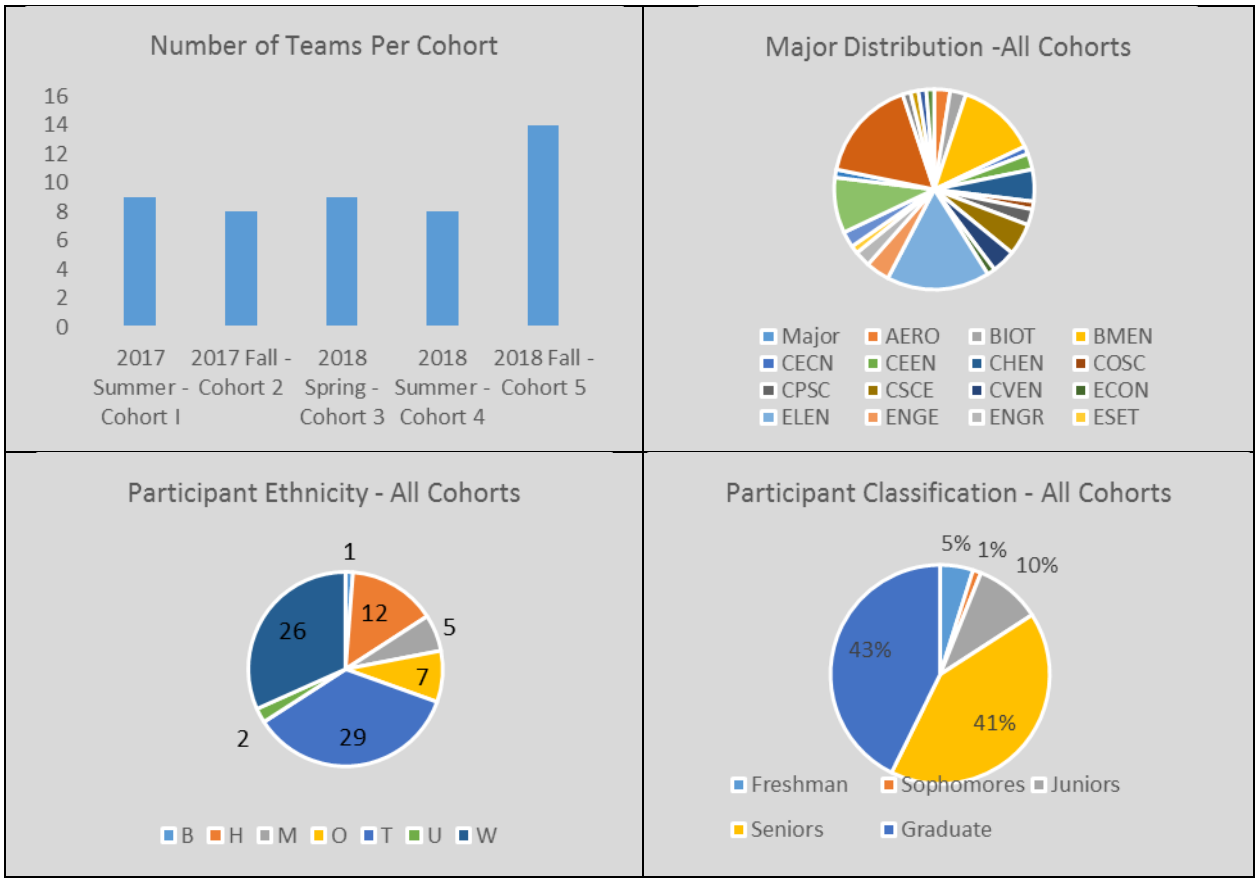

Figure 2. Number of participants per cohort and demographic characteristics of participants

C. Purpose of the Study

While a range of assessment instruments have been developed to assess entrepreneurial mindsets from high school students to seniors in college (e.g., [7]), the following research questions guided this study to understand the impact of the program for Cohorts 4 and 5 on student knowledge, perceptions, and practice of entrepreneurship.

- How does the program change student knowledge of entrepreneurship?
- How does the program affect student perceptions of entrepreneurship?
- How does the program improve student's ability to acquire effective customer discovery?

II. Method

A. Participants

During summer and fall 2018 for Cohorts 4 and 5, 35 out of 41 participants of the Site program at the university responded to at least one of the pre- and post-surveys utilized to assess the effects of the program. Among them, we only analyzed the data from 22 students who responded to both pre- and post-surveys. Figure 1 shows the demographic characteristics of the 22 respondents.

Table 1. *Demographic Characteristics of the Participants* (*N* = 22)

Category	Total	
	n	*%*
Gender		
Female	7	31.8
Male	15	68.2
Residence		
Domestic	13	59.1
International	9	40.9
Race/Ethnicity[a]		
Hispanic	2	9.1
Asian	1	4.5
Black	1	4.5
White	9	40.9
Track		
Undergraduate	13	59.1
Graduate	9	40.9
Major		
Aerospace Engineering	1	4.5
Biomedical Engineering	5	22.7
Chemical Engineering	1	4.5
Civil Engineering	1	4.5
Computer Science	2	9.1
Electrical and Computer Engineering	5	22.7
Industrial and Systems Engineering	4	18.2
Mechanical Engineering	3	13.6
Total	22	100.0

Note. [a]Race/Ethnicity was categorized for domestic students only.

B. Measures

Two types of measures were utilized as pre- and post-measures in this study: One quiz to assess the curriculum knowledge and another online survey to assess student perceptions and practice of entrepreneurship. The knowledge quiz consists of 15 questions presented with various types of questions, such as true or false, checking, matching, and ordering, but the maximum score available is 21 points. The online survey consists of four sections for the pre-survey and five sections for the post-survey: (a) current knowledge, (b) a scale on perceptions of entrepreneurship, (c) practice, (d) team and business model, and (e) program evaluation (post-survey only). We collected student demographic information from their application to the program.

Among those several measures, this study only utilize the data from the knowledge quiz, perceptions of entrepreneurship on the scale, and practice of customer interview skills captured in open-ended questions. As shown in Table 2, the scale was designed to assess student perceptions of the five constructs indicated by 27 items: (1) interest in entrepreneurship, (2)

confidence in value proposition, (3) self-efficacy in entrepreneurship, (4) self-efficacy in marketing/business planning, and (5) self-efficacy in customer interview skills. As an attribute-focused approach [8], we first identified the five constructs on entrepreneurship mindset that aligned with the Site program goals. Then, the items for each construct were generated by adopting items from the existing scales or constructing new items through the literature review [7] [9]. Students' responses were scaled on the seven-point Likert-type choices (1 = strongly disagree to 7 = strongly disagree).

Table 2. *Definitions and Reliability Evidence of the Constructs on the Perceptions of Entrepreneurship Scale*

Construct	Definition	No. of Items	Cronbach's α
Interest in Entrepreneurship	Students' interest in general aspects of entrepreneurship, including learning of entrepreneurship and being entrepreneur. (e.g., I have a general interest in the subject of entrepreneurship.)	6	.918
Confidence in Value Proposition	Students' confidence in identification of value propositioning through identification of value proposition, customer discovery and exploration of product-market fit (e.g., I am confident in defining an effective value proposition for my next idea.)	3	.927
Self-efficacy in Entrepreneurship	Students' personal belief in their ability to conduct entrepreneurship, taking various actions to set up business. (e.g., I can recognize when an idea is good enough to support a major business venture.)	8	.877
Self-efficacy in Marketing/ Business Planning	Students' personal belief in their ability to plan on marketing and businesses, taking actions for market and business research and operation. (e.g., I can follow the steps needed to place a financial value on a new business venture.)	6	.878
Self-efficacy in Customer Interview Skills.	Students' personal belief in their skills to conduct interview with customers to gather their constructive opinions on students' entrepreneurship activities. (e.g., I can develop interview questions, which allow me to collect qualitative and relevant data.)	4	.851
Total		27	.930

Note. The internal consistency reliability coefficient, Cronbach's α was calculated from the data including Cohort 6 participants who responded to pre-survey as of spring 2019 as well as other cohort participants who responded to either pre- or post-survey ($N = 60$).

Students' practice of customer interview skills were probed through one open-ended question on the pre-survey and two open-ended questions on the post survey as shown below.

- Please feel free to share the customer interview skills that you would like to improve more (pre-survey).

- Please feel free to share the customer interview skills that you have improved throughout the program (post-survey).
- Please feel free to share the customer interview skills that you would like to improve more (post-survey).

C. Data Analysis

Considering the small sample size, Wilcoxon signed rank *T*-test, a nonparametric counterpart of the paired samples *t*-test [10], was used to explore changes in participants' scores on the knowledge quiz and perceptions of entrepreneurship on the scale before and after the program. We also reported effect sizes [11].

To probe any changes in practice of customer interview skills, two authors of this study coded students' open-responses on the pre- and post-surveys. An inductive analysis and a creative synthesis strategy were employed to analyze the responses [12]. First, the two authors independently identified the themes that emerged in the data and coded the data based on their identified themes independently. Second, they held occasional meetings to reach a consensus on their independently identified themes. Third, they coded the data independently again based on the consensus themes, and then compared, discussed, and recoded until they reached a consensus on all of the coding. Finally, they labeled and described the themes and calculated the frequency of each theme appeared in students' raw responses. The frequency data were converted to the percentage of students who responded on each theme.

III. Results

A. Knowledge and Perceptions

Table 3 shows descriptive statistics of the knowledge test scores and perceptions of entrepreneurship, such as interest in entrepreneurship, confidence in value position, and self-efficacy in entrepreneurship, marketing/business planning, and customer interview, on the pre- and post-measures along with the nonparametric test statistics.

Table 3. *Changes in Student Knowledge and Perceptions of Entrepreneurship*

Knowledge and Perceptions	Pre			Post		Wilcoxon signed rank *T*-test			
	n	*M*	*SD*	*M*	*SD*	*T*	*Z*	*p*	*r*
Knowledge test score	21	11.05	2.09	12.43	3.14	123.5	1.682	.093	0.26
Interest in Entrepreneurship	22	6.14	1.12	6.20	0.95	92.5	0.305	.760	0.05
Confidence in Value Proposition	22	5.64	1.26	6.18	0.83	149.5	1.665	.096	0.25
Self-Efficacy in Entrepreneurship	22	5.19	0.85	5.66	0.73	183.0	2.351	.019	0.35
Self-Efficacy in Marketing/ Business Planning	22	4.23	1.17	4.83	1.04	166.5	2.299	.022	0.35
Self-Efficacy in Customer Interview Skills	22	5.39	1.08	6.45	0.67	211.0	3.328	.001	0.50

According to the Wilcoxon signed rank *T*-test, there was no significant changes between pre- and post-knowledge test scores, with $T = 123.5$, $p = .093$, $r = 0.26$, which represents a small effect of the change. Among student perceptions of the five constructs, there were no significant changes in student perceptions of interest in entrepreneurship and confidence in value proposition. However, students' self-efficacy in entrepreneurship, marketing/business planning, and customer interview skills were improved with medium effect sizes ranging from $r = 0.35$ to 0.50. Figure 1 delineates the changes in the perceptions of interests, confidence, and self-efficacy on entrepreneurship with 95% confidence intervals.

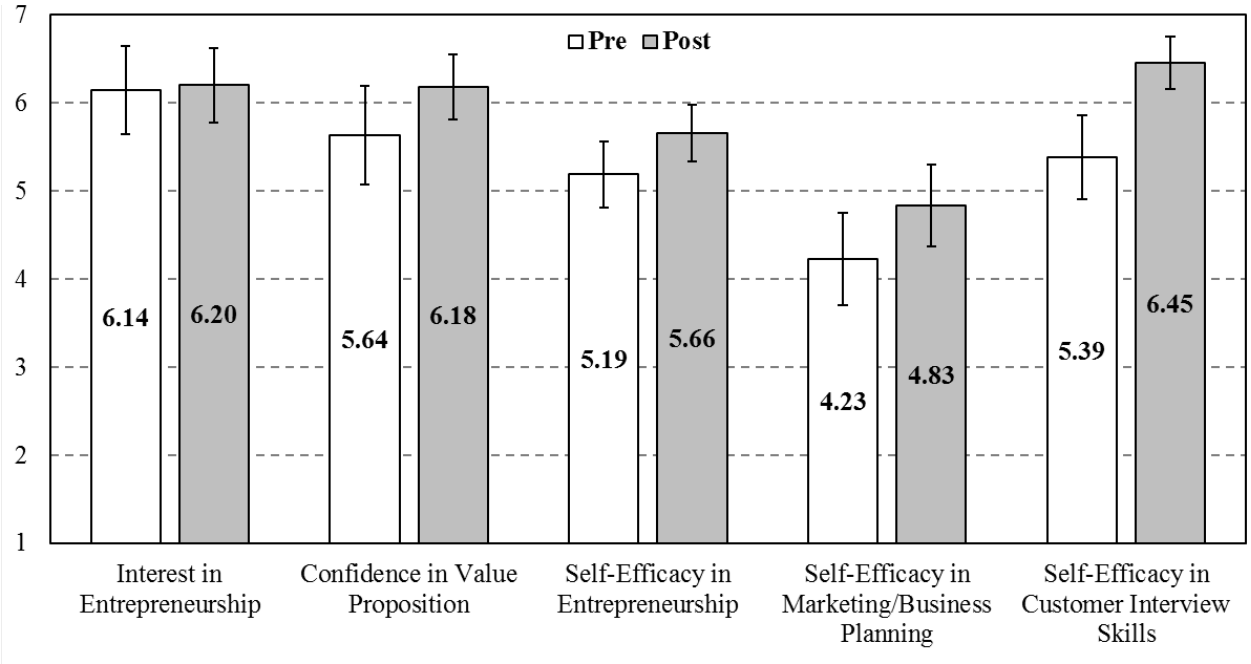

Figure 1. Changes in student perceptions of entrepreneurship

B. Practice: Customer Interview Skills

We identified seven themes that emerged from student responses on the three open-ended questions, as shown in Table 4. As noted, the themes emerged were broader than just interview skills as students addressed the customer discovery that encompasses value proposition and market identification, etc.

Table 4. *Themes Emerged from Open-ended Responses on Customer Interview Skills*

Theme	Pre (n = 19)	Post (n = 17)	
	Areas for Improvement	Improved Areas	Areas for Improvement
Formulating value propositions	0 (0.0%)	1 (5.9%)	2 (11.8%)
Market identification	2 (10.5%)	1 (5.9%)	2 (11.8%)
Formulating right questions	9 (47.4%)	10 (58.8%)	5 (29.4%)
Contact identification within the market	1 (5.3%)	2 (11.8%)	5 (29.4%)

Guiding discussion for useful customer feedback	6 (31.6%)	7 (41.2%)	4 (23.5%)
Communication/Marketing	4 (21.1%)	3 (17.6%)	2 (11.8%)
Interview presence	1 (5.3%)	6 (35.3%)	5 (29.4%)
Feedback analysis/Pivot	2 (10.5%)	1 (5.9%)	1 (5.9%)
Implementation of ideas	1 (5.3%)	3 (17.6%)	1 (5.9%)
Other	2 (10.5%)	1 (5.9%)	5 (29.4%)

Each theme was generated by determining consistent words and phrases across multiple comments. Table 5 shows a description of each theme appeared in Table 4 that now we consider them customer discovery skills.

Table 5. *Descriptions of the Themes on Customer Discovery Skills*

Theme	Description
Formulating value propositions	Developing a description of how the technology or service could solve a need or resolve a pain point for a selected customer segment
Market identification	Using databases and reports to determine market key words, Total available market (TAM), serviced available market (SAM), Targeted Market, and scope of the selected available market
Formulating right questions	Developing key hypothesis to test and forming open customer interview questions to validate the customer value for a given technology, product, or service
Contact identification within the market	Establishing connections with valid customers inside a targeted market and developing a network to expand the number of potential contacts
Guiding discussion for useful customer feedback	Managing the interview process during the discussion. Not an interrogation, but a guided discussion that leads to valid, verifiable input used to test a hypothesis. How to keep the conversation going to reach conclusions
Communication/ Marketing	Ability to communicate effectively the value proposition to potential customers and secure a meeting for in-depth discussions. Participants stated they need additional support in good communication skills and presentations.
Interview presence	The physical process of conducting interviews. Including initial introduction discussions, note taking, holding discussions, setting, body language, and concluding an interview.
Feedback analysis/Pivot	Identifying key themes from interviews and how to incorporate this information into changes in value propositions, target markets, and business model canvas changes
Implementation of ideas	After completion of customer discovery, developing a process to take the innovation to market that includes product development, fundraising, and addressing other important element of the business model canvas.

IV. Discussion

This study utilized pre- and post-surveys to assess the impact of the i-Corps site program on students' knowledge, perceptions and practice on entrepreneurship. Several notable findings were discussed below.

A. Knowledge and Perceptions of Entrepreneurship

The data on knowledge did not present any significant changes. However, the data on perceptions of entrepreneurship indicated that while student interest on entrepreneurship remained constant, there were significant improvements of participants in three areas of self-efficacy: (a) entrepreneurship, (b) marketing and business planning, and (c) customer interview skills. Even though there was an improvement in confidence in value proposition, the change was not statistically significant. As student interest on entrepreneurship is the fundamental motivator of the other constructs, driving positive actions in practice, we focused on the discussion of the following four areas below.

Confidence in Value Proposition. Engineering students have great problem solving skills and abilities to develop innovative ideas to solve problems. However, the traditional engineering curriculum does not usually focus on value proposition, customer discovery, and value creation. For that reason, Site participants spend significant time translating their innovative ideas into value propositions and customer discovery. Therefore, this finding is not surprising that they feel more confident in this area.

Self-efficacy in Entrepreneurship. Under this area, researchers requested feedback on participant ability to: (a) recognize ideas suitable for business, (b) develop hypothesis to be tested, (c) translate customer needs into requirements, and (d) lead technical teams. While overall participants reported positive growth in their ability to pursue entrepreneurship, future cohorts will receive additional training in translating customer needs identified in customer discovery to requirements and also leadership training.

Self-efficacy in Market and Business Planning. Site participants were asked to provide input on their ability to develop marketing plans, cost estimates for a new innovation, hire the right employees, develop a clear and complete business plan. Even though elements of these areas are discussed in the training, the six-week training does not allow us to expand in-depth on these areas and it is surprising that participants reported greater impact on this area than areas such value proposition. Perhaps, students believed that it is more straightforward to accomplish these tasks than others.

Self-efficacy in Customer Interview Skills. Students were also asked to rate their ability to develop interview questions, their ability to remain flexible during the interview, to avoid selling their product, and to focus on the customer needs**.** Data indicate that participants perceived significant growth in their ability to pursue effective customer interviews. This is to be expected as the training provides participants ample opportunities to work on the interview skills and practice these skills in class with others and Professors of Practice. However, as seen in the next section, participants indicated their desire for additional training to support customer interviews,

such as formulating the right questions, identifying customers, guiding the discussion, and interview presence.

B. Practice: Customer Discovery Skills

While we asked students to share the areas for improvement in interview skills, we identified four areas in which they desired additional improvement in customer discovery skills, beyond just interview skills: (a) Formulating the Right Question, (b) Contact Identification within the Market, (c) Guiding Discussion for Useful Customer Feedback, and (d) Interview Presence. It is interesting to note that Interview Presence showed the most significant improvement from pre to post with Formulating the Right Question second. While specific training on how to conduct interviews and developing interview questions was included in the course, and improvement was observed, additional training could improve student confidence and self-efficacy.

Guiding Discussion for Useful Customer Feedback is an area that requires a deeper discussion. In guiding discussions, students identified difficulty in keeping a discussion going after the question was answered. Customers provided the answers to the open-ended questions, but students seemed unable to continue to probe the topic by asking follow-on questions. They needed to allow their natural curiosity to guide follow-up questions to keep the discussion focused. In following cohorts, additional training, modeling, and practice interviews will be included to address this need.

Contact Identification is a recurring area for improvement that has been uncovered in both informal feedback sessions and was highlighted further in the data. Specific training was provided about building networks of contacts, asking customers for additional contacts at the end of an interview, and recommending using social media tools, such as LinkedIn. However, students continue to underestimate the amount of time and difficulty in establishing contacts, scheduling interviews, and building their network. Further, students rely too much on establishing connections via email rather than calling on the phone. Contact identification training will be augmented with metrics about how many potential customers have been contacted, method of contact, and source of contact. The concept of a sales funnel, where many contacts must be initiated to result in actual interviews, will be described and implemented.

It is important also to mention that several of emerging themes identified in this study are similar to the behavioral outcomes (actions) identified in the London et al. [13] proposed framework for documenting faculty and student outcomes related to Kern Family Foundation's "3Cs".

C. Lessons Learned

Over the past two years, we made several changes to the program to further align it with the needs of students on our campus and learned the following lessons: (1) recruiting qualified teams is challenging and collaborations with faculty and staff involved with potential candidates is very important, (2) recruiting qualified mentors in areas further away from large metropolitan areas is challenging and faculty and staff with industry experience (Professors of Practice, others) may serve in that role, (3) participants tend to focus their customer discovery efforts locally and may need guidance in identifying appropriate trade shows, and (4) the assessment allows us to get

immediate feedback of what parts of the Site program participants appreciate and others they need additional support.

D. Limitations of the Study and Suggestions for Future Research

There are several limitations in this study. First, the findings of this study conducted at a Southwestern university limits the generalizability of the results beyond the university due to the differences in the learning environment and entrepreneurship program at other sites. Second, while all participants were invited to take the pre- and post-surveys, the response rates were less than 50 %, which may cause sampling bias in responses. Third, due to the delayed planning of the assessment, this study was able to utilize the pre- and post-survey data from only two cohorts, which limited the statistical power with 22 participants, coupled with the low response rates. Therefore, there is a need to find a way to increase the response rates and the sample size. Fourth, while the reliability evidence of the scale was sufficient, the scale used in the surveys was not been validated yet. While the scale items were generated based on the existing scales/surveys in the literature, there is a need of validation because the scale as only been administered to the Site program participants at the university, whose count has not reached sufficient numbers for scale validation. We also acknowledge that the validity evidence of the scales is necessary before any statistical analyses. Fifth, while the pre- and post-surveys were the same across Cohorts 4 and 5, we did not capture any differences in student responses between two cohorts due to the small sample size, even with the potential possibilities of the program differences between two cohorts. Finally, since program participants represent a diverse group and also wide range of educational levels (freshman to Ph.D. students), we expect to evaluate the impact of the program with respect to gender, race/ethnicity, and classification in future studies with a bigger sample size. Further research is necessary to overcome the limitations of this study.

E. Conclusion

In this paper, we presented experience-based practice on an I-Corps Site implementation at a large Southwestern public university, some of the challenges faced and how they were addressed, and initial findings from the systematic program assessment [8]. Overall, the program provides great value for our on-campus ecosystem and it has been adjusted to meet the needs of our students. The survey data provided valuable feedback, confirming the effects of the program on students' perceptions and practice and identified areas that need further improvement for participants. These improvements will be incorporated in future cohorts along with additional new questions on market analysis such as their ability to evaluate markets (Total Available Market, Serviceable Available Market, and Serviceable Obtainable Market). This paper is expected to provide valuable information for institutions interested in pursuing an I-Corps Site grant and to those who have a grant but are looking for additional ways to further enhance the program impact on their campus.

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