

## **Work in Progress: The missing link in I-Corps Entrepreneurship Engineering Education at a Southwestern Institution**

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Magda Lagoudas, Executive Director for Industry & Nonprofit Partnerships, has been at Texas A&M University since 1992 and served on several capacities across the College of Engineering, including Director for the Space Engineering Institute and Associate Director for the Space Engineering Research Center. Current responsibilities include pursuing strategic partnerships with industry to provide engineering students with opportunities to collaborate on multidisciplinary teams addressing real world challenges and with industry engagement. College signature programs include the Texas A&M I-Corps Site, AggieE\_Challenge, INSPIRES, and two annual Project Showcases. Magda is the Principal Investigator of the Texas A&M University I-Corps Site grant and has been active in promoting entrepreneurship both at the local and national level. Member, Institute for Engineering Education & Innovation.

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### **Abstract**

Entrepreneurship education has made its way at most engineering institutions. Lean methods and the I-Corps culture have gained notoriety and momentum across the United States. At a Southwestern institution, designated as an I-Corps Site in 2017, continuous trainings (courses) are offered to undergraduate and graduate engineering students. During spring, summer and fall semesters, students are guided to conduct interviews with potential users of their innovations and refine their entrepreneurship skills. After seven years of successfully impacting students (blind for review 1 and 2) a team of investigators is looking into aspects of the training that might have been unperceived during prior assessments. In this study, we analyze via quantitative and qualitative methods, the answer to the research question: What aspects of the I-Corps Site program experience could be enhanced or modified based on performance and perceptions of participants? To answer this question, we focused on 2023 Summer Cohort, twenty students enrolled in an I-Corps site program experience that involved training and 6 weeks of customer discovery and answered to a pre- and post-surveys that included questions in the dimensions of: (1) interest in entrepreneurship, (2) confidence in value proposition, (3) self-efficacy in entrepreneurship, (4) self-efficacy in marketing/business planning, (5) self-efficacy in customer interview skills, and (6) current status of technology and business model. Preliminary quantitative analyses showed similar results to prior research about significant changes in student perceptions of confidence in value proposition, customer interview skills, and current status of technology and business model. However, in qualitative terms, when asked about their overall experience, those who rated it lower, expressed expectations not met related to training in market research and other entrepreneurship skills. This work in progress will present the case of those students who either did not express any expectations or their expectations were not met. Preliminary results show that some students may enter the experience with misconceptions of the type of training they will obtain, or they might be too advanced in their skills to take full advantage of the experience. The results of this investigation will bring light to current entrepreneurship trainings and trainers so more refined interventions can be offered.

**Disclaimer-**As a case study involving qualitative analysis, the intent of this investigation is to shed light into aspects that might have not been considered by prior quantitative investigations or emerging trends that further guide future investigations (e.g. item generation for another survey). It is not its intent to produce generalizable data to be applied to all instances of this training or the I-Corps Site training, or other entrepreneurship programs, in general. The results could however be considered for transferability to such other instances.

### **Introduction**

The I-Corps Site program at the Southwestern institution has been recognized throughout its seven years of existence by multiple studies (Lagoudas et al., 2019;2020). Overall, student participants feel very empowered and informed for a professional practice involving entrepreneurship and innovation. The only missing link has been of a minority group that did not express their expectations met or who missed to recognize the value of the program when asked in an exit survey. A team of researchers noticed this minority and devised a way to gather

information to complement the sounding success of this initiative. The goal of this investigation is to shed light into aspects that might have been missed or not considered by prior studies.

**Research question:** What aspects of the I-Corps Site program experience could be enhanced or modified based on performance and perceptions of select participants?

**The I- Corps Site Program:** The objectives of the I-Corps Site program are:

- Offer a comprehensive 6-week program annually to a minimum of thirty teams
- Increase the number of engineering students, in particular from underrepresented groups, gaining knowledge and skills on entrepreneurial mindsets.
- Increase the number of teams pursuing the National Teams program
- Enhance the on-campus ecosystem for entrepreneurship to support student /faculty innovations

The 6-week program comprises three elements:

- Training on value proposition, market analysis, customer identification, and customer discovery.
- Weekly individual meetings with assigned mentors
- Weekly status reports on customer discovery
- Customer discovery findings at mid-program and end of program
- All teams are expected to complete thirty customer interviews

Eighteen cohorts have been part of this training so far and two-hundred thirty seven teams have completed the program. The last cohort is underway in 2024 spring semester with twenty two teams. Teams work on innovations which are either student-led innovations or they work on innovations associated with faculty research. Nine Site teams have launched companies, one of them secured \$8M in funding in 2023, one won an international competition, fourteen teams have been awarded NSF's National Teams Award, and many won multiple local competitions.

### **Research Design**

The research approach taken to answer the research question was a sequential mixed-method in the form of a case study (Yasan, 2015). After running the same statistical analysis done by prior studies to the summer of 2023 cohort, and the results showing consistency with those prior works, it was decided to pursue interviews with selected individuals who ranked their overall experience with the training at the lowest levels. Then, after further research team discussions, the potential pool of interviewees was expanded to the Fall 2023 cohort as well as selected individuals of prior cohorts who continued communications with the trainers. This constituted a stratified-convenience sampling technique (Creswell and Creswell, 2017) with an ending result of six participants for the qualitative portion of the study. The instruments for each portion are described as follows:

**Quantitative.** The instrument employed was a pre and post-survey consisting of a closed ended questionnaire and an open ended section. The closed ended portion involved approximately 60 Likert-based items clustered in the following constructs: (1) interest in entrepreneurship, (2) confidence in value proposition, (3) self-efficacy in entrepreneurship, (4) self-efficacy in marketing/business planning, (5) self-efficacy in customer interview skills, and (6) current status of technology and business model. The Likert-scale was based on 7 levels, from **SD** = Strongly disagree; **MD** = Moderately disagree; **D** = Disagree slightly more than agree; **N** = Neutral/Neither Disagree Nor Agree; **A** = Agree slightly more than disagree; **MA** = Moderately agree; to **SA** = Strongly agree.

**Qualitative.** The open-ended portion of the pre- and post-survey involved a set of questions of the type: “ If you intend to use the information and ideas from the program in other ways, please describe them here.” To expound on the answers given to those open-ended questions, and after the discussions leading to the decision to include interviews, a semi-structured interview protocol was developed by the research team as follows:

1. Tell us about you, what is your engineering background and what is your interest and experiences on entrepreneurship and I-Corps?
2. Based on the response provided during the end of program survey <read the answer>, can you provide us with more explanation-description of your answer?
3. Before and after the program, can you tell us how has it impacted your understandings <if recent> or professional experiences <if not as recent>?
4. Are there things that you consider missing or potential improvements to the program?
5. Are there recommendations on how to target the specific group you belonged during the training to make it more enticing to that specific audience (undergrad, freshman, graduate level)?
6. If you have any other suggestions or recommendations to the program, can you provide them to us?

**Participants**

The I-Corps Site program targets undergraduate and graduate students in the College of Engineering. About 33% of teams pursued innovations associated with faculty research while 67% focused on student-led innovations. Participants include students from the freshman year to graduate students, students in medical school and post-docs. They represent all engineering majors, medical school, and some other majors.

For the quantitative part of the analysis, the summer 2023 cohort was comprised of twenty students with the demographics as shown in Table 1. The qualitative portion of this study consisted of four participants, two from the summer of 2023 cohort one from the fall of 2023 and one from the fall of 2019. The demographics for the four participants are in Table 2.

Table 1. Summer 2023 I-Corps Site Cohort Demographics

2023 Summer I-Corps Site Cohort	
<b>Gender</b>	
<b>Female Participation</b>	<b>21%</b>
<b>Male Participation</b>	<b>79%</b>
<b>Ethnicity Distribution</b>	
<b>Other (O)</b>	<b>46%</b>

<b>Multiracial (M)</b>	<b>5%</b>
<b>Asian (A)</b>	<b>18%</b>
<b>White (W)</b>	<b>26%</b>
<b>Hispanic (H)</b>	<b>5%</b>
<b>Classification Distribution</b>	
<b>Graduate Student - G8</b>	<b>77%</b>
<b>Undergraduate Senior - U4</b>	<b>18%</b>
<b>Undergraduate Sophomore - U2</b>	<b>5%</b>

Table 2. Demographics of Participants in Interviews using Pseudonyms

<b>Category</b>	<b>Subgroup</b>	<b>Carl</b>	<b>Alex</b>	<b>Gustav</b>	<b>Louis</b>	<b>Ronald</b>	<b>Owen</b>	<b>Total</b>
<b>Gender</b>	<b>Female</b>							
	<b>Male</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>6</b>
<b>Race/</b>	<b>Hispanic</b>							
<b>Ethnicity</b>	<b>Asian</b>	<b>x</b>	<b>x</b>		<b>x</b>	<b>x</b>		<b>4</b>
	<b>AI/AN</b>							
	<b>Black</b>							
	<b>White</b>			<b>x</b>			<b>x</b>	<b>2</b>
	<b>Multiracial</b>							

<b>Level</b>	<b>Undergraduate</b>			<b>x</b>				<b>1</b>
	<b>Graduate</b>	<b>x</b>	<b>x</b>		<b>x</b>	<b>x</b>	<b>x</b>	<b>5</b>

*Note.* AI/AN is American Indian and Alaska Native

## **Findings and Discussion**

### **Quantitative**

The quantitative analyses, involving Wilcoxon signed rank T-test, revealed similar results to prior research about significant changes in student perceptions of confidence in value proposition, customer interview skills, and current status of technology and business model (Lagoudas et al., 2019;2020). This prompted the research team to look into additional ways to enrich the I-Corps Site program at the institution and the research question emerged ***“what aspects of the I-Corps site program experience could be enhanced or modified based on performance and perceptions of participants?”*** To answer it, we continued with the qualitative portion of the study.

### **Qualitative**

The I-Corps Site training program has received overwhelming support and positive feedback for years since its inception. Through coordination with the program director and available resources, we can conclude that participant evaluations of the program are positive and mixed, and there are four challenges, or room for improvement, that participants reflected on after the program: (1) participant variation, (2) I-Corps’ role in entrepreneurship-innovation learning processes, (3) mentorship, and (4) time constraints. The following paragraphs provide descriptions of these themes with participants’ excerpts to exemplify them.

### ***Participant Evaluations***

To get a greater understanding of the I-Corp program, a better understanding of how the participant reacted to being in the program itself became necessary. During the interviews with each of the participants we found that there were two types of perceptions, those giving (1) positive evaluations and (2) mixed evaluations.

#### ***Positive Evaluations: Refer to evaluations of students in the positive.***

“I think the most positive part of the program was interviewing people. And I think it was a lot easier to set up interviews with people when you say, ‘I’m part of an NSF I-Corps program. I’m interested in learning more.’ So that was definitely a very positive experience.” - Ronald

#### ***Mixed Evaluations: Refer to assertions where evaluations were ambivalent, especially after requesting recommendations.***

“Everyone has an innovation, and it all probably started on one of their {school} projects. But what happens is, you have a professor, you work, of course under a professor and he has so much to do in his life teaching and stuff. So he forgets about that part, and he

doesn't take it further. And I think that's the part where I think the faculty plays a role with not allowing the student to go further with an innovation... So I think if more freedom like. I know, I-Corp requires you to have a faculty or 2 students... So you might need to target the faculty more to go further worth their innovation.” -Alex

### ***Program Challenges (Room for Improvement)***

From the literature, the available data provided to us by the program director, and the interviews that were conducted by a member of the team, we were able to identify four themes catalogued as challenges: (1) participant variation, (2) where I-Corps falls in the process of innovation, (3) mentorship, and (4) time. They are described next:

***Participant Variation: Refers to the wide array of students who participate in I-Corps, in terms of discipline, age, interests, and place in the entrepreneurial process and how challenging it could be to deliver a program relevant to this variation of participants.***

“So {it's} not like not every size fits all. If you want to target different groups. So maybe a little bit different approach, right? For example, if you want to send an email in computer engineering or computer science, you might mention to them that you support creation of apps” -Carl

***I-Corps in the entrepreneurship-innovation learning process: Refers to the students wanting to know more about the stage in the entrepreneurship-innovation learning process they are and what they still need to learn.***

“We know what to do now, for example, customer discovery. Maybe we know the next step or the next step, but I don't know the fourth step or the fifth step, and as in the game of chess, you need to sort of envision. What's the pathway?... So I don't know the entrepreneur journey, right? What's the journey of entrepreneur? I don't know what are the final steps, and how does it work?” -Carl

“We never focused, at least in my class experience, I could also be wrong from where things are today because I graduated 4 years ago, but things like building a minimum viable product... So something that's actually in production, and going out and selling it to the world and seeing what happens, iterating on feedback, getting conversations. The classes that I took were always around kind of startup methodologies, ideas, business case building, that kind of thing.” -Owen

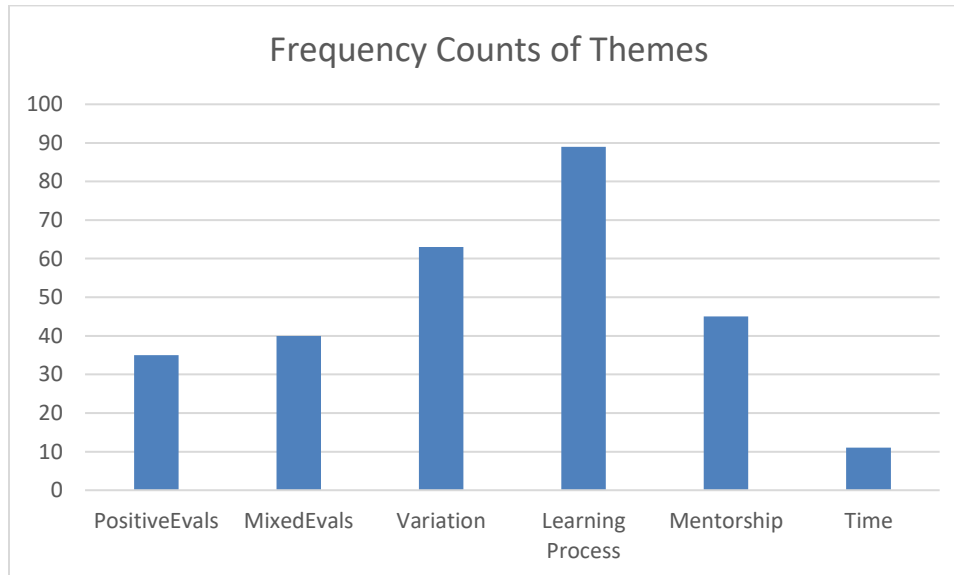
***Mentorship: Refers to the match between the mentor and mentee in the program***

“What a lot of mentors tried to push us to do, which we weren't very interested in, was to try and market a for-profit product with our idea, our idea was mostly to research a market for an organization that would benefit students. Not necessarily make a profit.” -Gustav

***Time: Refers to the time of the program***

“These 6 weeks went like a snap. Somehow we are able to complete the interviews, but if the time frame is a little longer, it would be more valuable to us.” -Louis

Figure 1 provides a schematic of the frequency these themes as mentioned by participants. As can be noticed, the I-Corp place in the entrepreneurship-innovation learning process was the most cited theme.



**Figure 1. Frequency of times themes were mentioned by participants.**

### **Research Quality (Trustworthiness) and Transferability of Results**

In all qualitative studies, ensuring the trustworthiness of research is critical from the research design phase. Since this case study follows a sequential mixed-method structure, where the initial set of data was provided to the research team, the steps taken to maximize the credibility of results included the following:

**Referential Adequacy:** This was guaranteed through interviews recorded and transcribed for access by multiple individuals in the research team. It also included access to the raw data collected during the exit survey and other resources such as photographs of notes taken when discussing findings or other aspects of the research. All these artifacts are kept in a shared drive under the institution's electronic dominion (Lincoln and Guba, 1985; Schwandt et al., 2007).

**Peer Debriefing:** This was implemented during regular weekly research team meetings occurring during the research design, data collection, data analysis, and reporting phase of this study (Lincoln and Guba, 1985; Nassaji, 2020).

**Audit Trail:** This was implemented via the opportunity to trace back all the steps taken in the planning and execution of this project. Also, via all artifacts saved in the shared drive mentioned above (Lincoln and Guba, 1985; Nassaji, 2020).

**Researcher's Journal and Triangulation:** There is a journal that the lead researcher keeps recording conversations available to all involved in the project as well as notes taken during conversations and reflections done while revisiting the project. Triangulation of data, where the identity characteristic is the multiplicity of data sources, was ensured via the two main data sources: the closed and open-ended survey and the semi-structured interviews (Yin, 2009; Denzin, 2007).

**Transferability of Results:** This can be achieved through careful analysis of common characteristics that other entrepreneurship initiatives have. For example, the result related to the confusion some participants had about the I-Corps portion covered in the entrepreneurship



learning process might be of interest to those who teach or learn other parts of this learning (e.g., financing, supply chain) and want to refine the way they teach innovation and entrepreneurship.

### **Limitations and Implications for Practice and Research**

The limitations of the study pertain to the number and selection of participants. As a case study, the objective was not to provide a comprehensive study but a basis for a more extensive investigation of issues that might have been missing from prior research. The approach to this inquiry should be that of an exploratory study. The research team is already committed to continuing the research in a longitudinal study.

The implications for practice, in the words of the program director, include that: (a) it is demonstrated how some undergraduate students may be at a level of maturity that can be challenging when pursuing customer discovery - such students benefit less than those advanced students with a more mature view of innovations; (b) students entering the I-Corps Site program come with different needs, and it could be beneficial to identify those needs before entering the program, and (c) the ecosystem where the institution is located could potentially be considered advantageous for mentorship opportunities.

The implications for research are vast for the expansion of this exploratory inquiry. First, this could be the basis for a more comprehensive qualitative study with clearly identified strata for the seven years the program has been in place. Social identities such as females, underrepresented groups in engineering, and intersectional demographic groups could be inserted into these strata. Second, with a wider qualitative study, a quantitative instrument could be developed for dissemination nationwide. Such a comprehensive study has the potential to unveil not only matters pertaining to the local ecosystem but those of general prevalence.

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