

WIP: Entrepreneurial Identity Formation in First Year Bioengineers

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Introduction:

There has been much work on the development of entrepreneurial thinking in engineering students. [1,4,5] These studies emphasize the needs to train our students to be innovative and entrepreneurial minded to meet the changing technological needs of society. [1] This mindset provides students “the knowledge, tools, and attitudes that are required to identify opportunities and bring them to life” [1]; however, this definition of entrepreneurial thinking is multifaceted and encompasses a broad range of concepts and skills. Broadly speaking, entrepreneurial thinking includes “specific aspects of systems planning, operationalizing innovative ideas, establishing organizational culture by example, big picture thinking, problem posing, thinking outside the box, realizing a vision, institutionalizing best practices, taking risks, learning from failure, founding startups, persuading others to follow, catalyzing change, market savvy, and identifying opportunities.” [3,6] From this statement, entrepreneurial thinking can employ several different people to go from the identification of a need to actualization of a solution to that need. Drilling down into entrepreneurship, these concepts include a variety of ‘entrepreneurial engineering identities’ (EEI) that have been described as founder, developer and inventor. [3] Founders are people who want to create firms/companies based on ideas or social motivations. Developers are people who want to take nascent firms/companies further than just initial stages. Finally, inventors are people who want to identify and propose solutions to problems. To our knowledge, there is no set path from one identity to another nor is a person consigned to engaging in single identity. Our question is how do these identities develop within engineering students. Traditional engineering courses focus on technical problem-solving skills with many programs adding design thinking concepts to these classes. This work falls within the ‘inventor’ identity. A previous study supports this idea and showed that our junior-level engineering students mainly identify with being “inventors.” [3] We hypothesize that first-year students exposed to all three entrepreneurial engineering identities will foster an understanding in the behaviors needed to take products to market and enhance an interest in other available identities in addition to ‘inventor’.

Methods:

The knowledge of how to take a potential idea and move it further than technical design is not in any required coursework for our engineering disciplines. Thus, many students may be unaware of all approaches needed to translate ideas into actual marketable concepts. These additional concepts are best described by “persuading others to follow”, “market savvy”, “catalyzing change”, and “operationalizing innovative ideas,” which are found more with the “founder” or “developer” identities. Can these skills be taught or do the students come in with a predilection for any or all entrepreneurial identities? We have revised our introductory bioengineering course to include materials and activities for students to be introduced to the ‘founder’ and ‘developer’ concepts. In addition to existing modules on entrepreneurial thinking, we invited guest speakers from the business school (customer empathy interviews), the Department of Engineering Management (patents) and others who can speak firsthand on the experience of being a founder or developer. Throughout the course, as we covered the design thinking process, we made reference to how an inventor, founder or developer would respond in different instances. In addition to interventions in class, we organized a workshop for all College of Engineering students titled “Engineering Entrepreneurial Identity: Where do you see yourself” in Fall 2020. Students in the class attended as extra credit. This workshop consisted of a presentation by an alumnus who embodies all three identities. He has invented a product from which he has founded a company and developed it into a marketed product. After questions for the speaker, the students were divided into three breakout rooms where they brainstormed actions of an ‘inventor’, ‘founder’ or ‘developer’ in specific scenarios. Students participated in all three rooms before we wrapped up together.

Student surveys [adapted from 2] were conducted at the start of the semester to determine if students enter our program with one or more of the EEI. The survey questions were based on a 5-point Likert scale with 5 – “strongly agree,” 3 – “neutral,” and 1 – “strongly disagree”. There were 5 questions exploring ‘inventor’, 4 questions for ‘founder’ and 4 questions for ‘developer.’ [6] Questions also included

demographics (male vs female) and past exposures to entrepreneurship (self or parents). Post-class surveys were conducted to see how student perception changes with additional exposure to the identities of founder and developer. This survey was deemed “exempt” by Temple University’s IRB committee.

Survey results were compared with data from recent engineering upperclassmen before and after their senior capstone courses [3] and experienced entrepreneurs [2] to determine if our program revisions are influencing the development of all EEI in our bioengineering program. Cardon et al. reported a single question for each identity with her experienced entrepreneurs. We used the same questions in our comparisons (Figure 1). [2] Single factor ANOVA tests were conducted to determine differences in responses to the EEI for both pre and post surveys with paired t-tests for post-hoc analyses. t-Tests with unequal variance were used to determine differences between positive and negative responses in pre- and post- intervention surveys with regards to gender and prior exposures to entrepreneurship.

Results:

We had 53 unique responses (28 female, 25 male, 1 no response) to our pre-intervention survey from 2 sections and 45 unique responses (25 female, 20 male) to our post-intervention survey for Fall 2020. Average Likert scores were used to determine potential changes of affinity for each of the EEI (Figure 1). There were no differences between male and female respondents for affinity to any of the EEI so class data for each time point were combined. Parental entrepreneurship activities, such as owning a business or inventing a product/service, did not affect affinities for any of the described engineering identities aside from ‘founder’ for pre-surveys. ($p < 0.05$) This affinity was not seen in the post-survey data. Students who had prior entrepreneurial experiences, such as starting a business or inventing a product/service, showed particular affinities to all EEI in both the pre- and post- surveys. ($p < 0.03$ or < 0.001) Comparisons between pre- and post-survey responses (44 unique responses) showed that the course interventions did not improve any affinities towards the EEI. Similar pre/post survey comparison results were seen with the upper-level engineering students.

Similar to reported upper class student data [3], our students showed a strong and significant identification with ‘inventor’ (answers of ‘5’ or ‘4’) questions for both the pre- and post-surveys (74% and 71% respectively) over ‘founder’ for pre and post ($p < 0.001$), but only ‘developer’ in the pre-survey ($p < 0.001$). There was lower interest for students that showed affinity for the ‘founder’ (33% both pre and post). While for the ‘developer’ identity, there was a large increase in interest towards this identity (54% and 69% for pre- and post). These ‘developer’ results were significantly different from ‘founder’ for both pre and post survey ($p < 0.001$). (Figure 2)

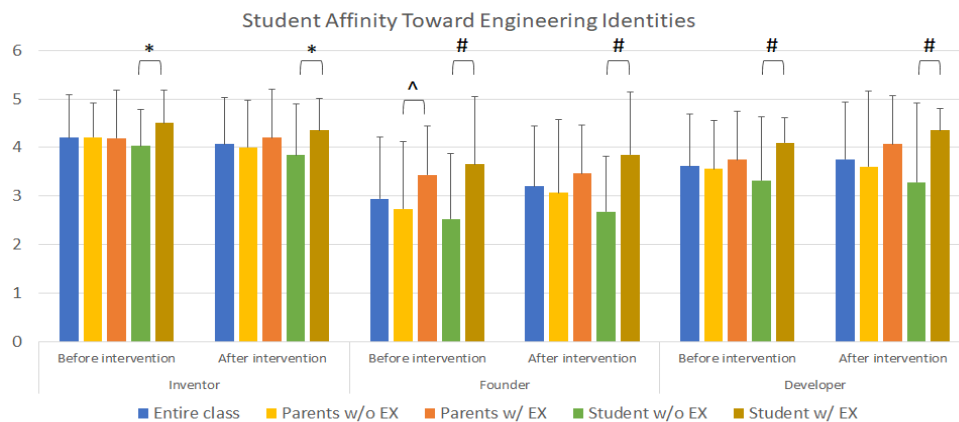


Figure 1: Average (SD) Likert score of engineering identities for freshmen (before and after course interventions). Significance was determined within each group for those responded positively vs negatively to the demographic statement. ^ $p < 0.05$, * $p < 0.03$, # $p < 0.001$, EX - entrepreneurial experience; w/ - with; w/o - without.

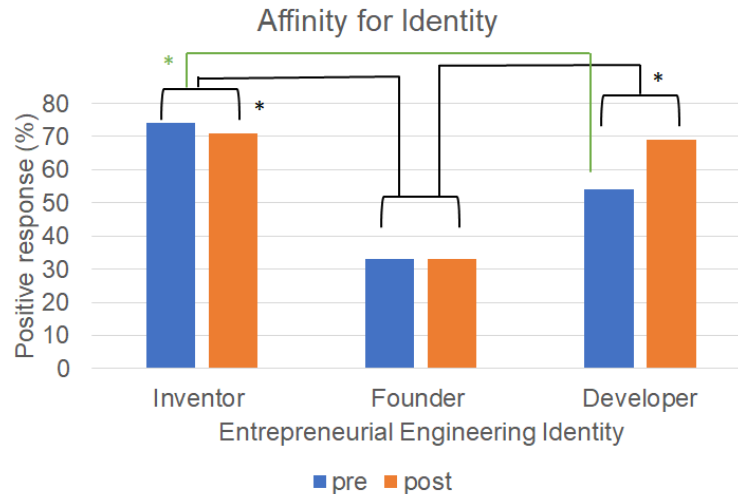


Figure 2: Affinity towards each identity based on Likert scores of '4' and '5' on EEI questions based on pre- and post-intervention surveys. * $p < 0.001$

Discussion:

Prior to our curricular intervention students demonstrated an affinity for 'inventor' that was considerably greater than the other two identities. After the intervention, the affinity for 'inventor' was still strongest but affinity for 'developer' had increased while affinity for 'founder' had not changed. This was very similar to results in upperclassmen from Edwards 2018. These affinities are not affected by gender as was seen in prior studies. [4] With the exception of 'founder', having an entrepreneurial parent had no effect as well. These results differ from Li et al., who stated that having close entrepreneurial relatives was positively aligned with increases in entrepreneurial mindset. However, their definition of entrepreneurial mindset encompassed all of our EEI. There seems to be a movement of student interest from 'inventor' to 'developer' in general as students work through innovative, open-ended projects, such as senior capstone or our introductory bioengineering final project. Students who identified as having previous entrepreneurial experience demonstrated a greater affinity for 'founder' and 'developer' than students who did not claim this experience. The previous entrepreneurial experience of these students ranged from establishing a limited liability corporation in support of freelance teaching to the invention and promotion of new technological products. Future work will include focus interviews with students to determine the extent of entrepreneurial experiences and how those experiences shape ideas for these students in college. Cardon et al. showed that experienced entrepreneurs showed high affinity with all identities (mean Likert values > 4) [2], where this was only seen in the 'inventor' identity in this study. Our focused EEI interventions, in class or extracurricular, produced a small shift towards the 'developer' identity but this was also seen in the upperclassmen without a specific intervention. [3] We also are reviewing our course interventions to determine if better methods can be employed such as including more active learning projects to improve student engagement with each identity. Finally, we will follow up with the students as they progress through their academic careers to see if any of them continue projects through to prototyping and testing stages or present ideas at entrepreneurial competitions or conferences.

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