

Unpacking the Impact of Engineering Entrepreneurship Education that Leverages the Lean LaunchPad Curriculum

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Abstract— The role of entrepreneurship in engineering education has undergone a substantial transformation over the last several years. Engineering entrepreneurship has evolved from the traditional business school model, focusing on business skills and business plans, to include cultivating an entrepreneurial mindset to enhance engineers' professional formation. Engineering programs are incorporating entrepreneurship into both formal and informal learning through the integration of formal courses, pitch competitions, mentorship, start-up weekends, and maker-spaces into student offerings. While it is becoming generally accepted that entrepreneurship education requires active student-learning pedagogies, assessment of student learning in relation to these pedagogies is still evolving. Of the few existing engineering entrepreneurship assessments, most have broadly assessed students' perceptions of business skills and knowledge, self-efficacy, attitude towards entrepreneurship, and entrepreneurial intent. However, with the considerable amount of variance in course content and instruction, further comparative research in controlled entrepreneurship education environments is needed to accurately assess student outcomes. The recent widespread adoption of the Lean LaunchPad Curriculum and Business Model Canvas has recently provided engineering programs with straightforward, common curriculum and pedagogical approaches, as well as an opportunity for targeted assessment across institutions. Prior to the Lean LaunchPad curriculum, there was no consensus on introductory entrepreneurship content and delivery for non-business students. The purpose of this study is to examine the impact of the Lean LaunchPad curriculum and pedagogy on undergraduate students with regard to self-efficacy, behavior, and knowledge. In this study, entrepreneurial self-efficacy was measured using a validated survey from existing entrepreneurship research. Additionally, a validated entrepreneurial behavior inventory was used to assess entrepreneurial behavior, as opposed to measuring behavioral traits and attitudes. To examine

entrepreneurial knowledge, students were asked to complete open-ended survey questions to determine how they would pursue a new venture at different stages of development. The preliminary results of these surveys are discussed in this paper in an effort to better understand the impact of the Lean LaunchPad Curriculum on student outcomes.

Keywords—*Lean Launch; Business Model Canvas; engineering entrepreneurship education; assessment*

I. INTRODUCTION

Engineering education at postsecondary institutions has been undergoing significant reform over the last 20 years in an effort to meet new challenges facing 21st century engineers [1], [2]. Recognizing the need to educate engineering students to not only be technically deep, but also prepared for the increasingly global labor market, colleges and universities have been exploring different ways of expanding engineering student experiences. Current approaches to achieve these aims include: encouraging students to study abroad, increasing opportunities for hands on design experiences, and integrating entrepreneurship training in the engineering curriculums [3].

While entrepreneurship education has historically been a business discipline [4], there has been significant growth outside of business schools. In 2010, it was reported that more than 50% of ASEE member institutions had some type of entrepreneurship program for their students [5]. In 2011, Stanford University and VentureWell (formally known as the NCHIA) teamed together to form the National Science Foundation (NSF) funded Epicenter, the National Center for Engineering Pathways to Innovation [6]. The mission of Epicenter is to “empower U.S. undergraduate engineering students to bring their ideas to life for the benefit of our economy and society[7].” As of June 2015, Epicenter had helped 37 different engineering institutions incorporate innovation and entrepreneurship into their undergraduate

curriculum[8]. The Epicenter University Fellows Program has created a network of over 600 undergraduate fellows representing 143 institutions, empowering students to become agents of change on their home campuses [8].

While these efforts have resulted in a significant increase in engineering entrepreneurship education initiatives, research in engineering entrepreneurship education outcomes is still emerging. Over the past several years, there have been several efforts to characterize students participating in engineering entrepreneurship education, but they are large scale studies that aggregate student responses across several institutions [9]–[11]. Duval-Coutiel et al. [12] collected data from 501 engineering students enrolled in a senior level capstone design class from three different universities. Students were surveyed for student characteristics, perceptions of the integration of entrepreneurship into their curriculum, student interest in entrepreneurship and student involvement in entrepreneurship activities. Shartrand et al. [10] developed the NCIIA Entrepreneurship Inventory and surveyed engineering students of various levels at 10 different universities. The NCIIA Entrepreneurship Inventory focused on student perceptions with respect to becoming an entrepreneur and their topical knowledge regarding: finance and accounting; people and human resources; sales and marketing; product ideation, and development. Finally, the most recent survey performed by Jin et al. [11], examined responses from 989 business and engineering students from 51 different U.S. universities and colleges to characterize student career goals and attitudes, and personal characteristics. While these studies have offered a great deal of insight into the types of students participating in engineering entrepreneurship programs, the actual impact of the educational experience itself is still difficult to determine. Engineering entrepreneurship programs have evolved to become complex networks of diverse courses, active learning pedagogies, and co-curricular programming [13]–[15].

Recently, engineering entrepreneurship programs have started to adopt the Steve Blank Lean LaunchPad entrepreneurship curriculum. This adoption is offering new opportunities for examining the influence of entrepreneurship education on student outcomes. For the first time, large numbers of students are being taught the same curriculum across institutions. The purpose of this study was to create a pilot survey that could be used to measure student entrepreneurial self-efficacy, entrepreneurial behavior and entrepreneurial knowledge before and after participating in a Lean LaunchPad entrepreneurship course.

II. LEAN LAUNCHPAD ENTREPRENEURSHIP CURRICULUM

In recent years, the Lean LaunchPad approach to teaching entrepreneurship education has been widely adopted in engineering schools. The rate of this adoption can be attributed to the incorporation of the curriculum into the National Science Foundation I-Corps program. Fundamentally, the Lean LaunchPad curriculum teaches students how to identify the critical business features necessary to make an idea scaleable and repeatable through customer discovery [16].

A. Business Model Canvas

The Lean LaunchPad curriculum is taught in the context of Alexander Osterwalder's Business Model Canvas (BMC) [17]. The BMC is a visual representation of the nine fundamental components of a business: value proposition, customer segments, customer relationships, channels, key partners, key activities, key resources, costs, and revenues. There are two critical features of the BMC. First, the canvas offers a common vocabulary for business development. Second, students can see how changes to one component influences other components, and ultimately the costs and revenues.

B. Customer Discovery

Customer discovery, popularized by serial entrepreneur Steve Blank, is the actual acquisition of information from potential customers through interviews [16], [18]. Students are encouraged to learn more about their business ideas by first talking to potential customers to identify what the true customer pains or needs are before creating an entire business. The goal is for students to truly understand the customer's job and the challenges that the customer addresses to fulfill his/her job. This insight is meant to help students identify solutions that will specifically address the customer's needs, thus identifying the product market fit. Blank argues that this information cannot be found in books or from research on the internet. He argues that founders must be in contact with potential customers and users before prototypes or business plans are created. Additionally, students are encouraged to interview large numbers of customers to fill out the BMC and continue to iterate on the BMC process based on findings from the customer interviews.

III. METHODS

A. Participants

Study participants were undergraduate students enrolled in three different sections of a capstone entrepreneurship course offered by an engineering school in the Midwest using the Lean LaunchPad curriculum. Participants represented a variety of disciplines including: engineering, science, arts and humanities, and social science. Forty-four participants completed the pre- and post- course surveys. Anonymous student generated identifiers were used to pair pre- and post-course data.

B. Survey

Students were asked to complete a survey that covered four topics: participant characteristics (7 items) entrepreneurial self-efficacy (23 items), entrepreneurial behavior (12 items), and entrepreneurial knowledge (4 items). Participant characteristics surveyed included gender, age, area of study, years of education, ethnicity, previous participation in entrepreneurship programs, and family entrepreneurial experience.

Items measuring entrepreneurial self-efficacy (ESE) and behavior were taken from validated surveys [19], [20]. The 2009 McGee et al. measure [19] for ESE consisted of five different constructs: searching (3-items), planning (4-items), marshaling (3-items), implementing (people) (6-items), and implementing (financial) (3-items). The five constructs are

defined in Table 1. They also created a construct for measuring attitude towards venturing (3-items). The McGee et al. measure was specifically chosen because it is one of the first (ESE) models that included nascent entrepreneurs for model validation, offering more insight into student development of ESE.

Table 1. Five Entrepreneurial Self-Efficacy Constructs as Defined by McGee et al. (2009)

Searching	Identifying opportunities
Planning	Converting ideas into plans
Marshalling	Assembling resources for execution
Implementing	Execution, growing, sustaining the business with respect to people and finances

Entrepreneurial behavior was measured using the Lau et al. [20] entrepreneurial behavior inventory. This instrument was actually developed to measure entrepreneurial behaviors of corporate managers. Lau et al. found this four-factor measure to be valid and reliable for executive-MBA students. The four-factors were innovativeness (3 items), risk taking (3-items), change orientation (3-items), and opportunism (3-items). The four factors are defined in Table 2. While the authors of this manuscript realize that undergraduate entrepreneurship students do not share the same experiences of executive MBA students, this was the one validated measure for entrepreneurial behavior in the literature to date. Other researchers commonly use entrepreneurial intent [21], [22] as an analogue of entrepreneurial behavior, as opposed to directly measuring behavior.

Table 2. Four Entrepreneurial Behavior Factors as Defined by Lau et al. (2012)

Innovativeness	Behavior of creating new or improved services or products
Risk Taking	Taking risks for the sake of profit, To take bold actions
Change Orientation	Proactive approach to taking initiative
Opportunism	Recognizing and exploiting opportunities to develop new products

Measures for assessing entrepreneurial knowledge in the context of the Lean LaunchPad curriculum have yet to be developed. Thus, students were instructed to answer four open-ended questions developed by the authors, which were designed to capture students' thought processes as they prepared to launch a new product. All four questions were in the context of creating a new cell phone app to help diabetic patients manage their disease. The four questions were as follows: 1) You have been tasked with evaluating whether or not this app should be brought to market by the company. Describe who you would speak to, why you want to speak to these people, and how you would make contact with them; 2) An elderly woman is having trouble managing her diabetes. Describe at least five steps you would take to determine if this cellphone app would be a potential solution for her problem; 3) In speaking with potential users, you discover that the majority of diabetic patients are over the age of 60. Describe how this

might influence your company's next steps with the app; 4) Your company tasks you with putting together a team of people to make a final decision about bringing the app to market. Describe who would be on your team and how you would help ensure that the team would be successful.

C. Analyses

For the quantitative analysis, SPSS 21.0 was used to conduct the statistical analyses and simple confirmatory factor analyses. Simple confirmatory factor analysis was performed to explore the unidimensionality of self-efficacy and entrepreneurial behavior items.

ESE scores were calculated for each survey respondent by calculating the mean of their scores for each ESE construct. Paired t-tests were run to compare pre- and post ESE scores. A multivariate analysis of variance (MANOVA) was also performed to investigate the variance in scores on identified self-efficacy scales that could be explained by the common demographic variables of familial experiences with entrepreneurship, previous experience with entrepreneurship, gender, age, major, and ethnicity.

Due to the nature of the behavioral inventory used for this study, item scores were not equivalent to survey responses. Each response was a narrative (i.e. 1. Try to fix it yourself or 2. Call the computer department to repair it) and respondents indicated their preferred response by selecting the ordinal associated with the appropriate narrative. Item scores that corresponded to each narrative are given in Lau et al. [20]. Thus, student responses were first converted to the appropriate item score. Entrepreneurial behavior scores were then calculated for each respondent by calculating the mean of their converted scores.

The open-ended questions regarding student knowledge were coded and categorized based on recurring themes. Themes were identified collaboratively, with two authors discussing appropriate themes until a common coding structure was established. Inter-rater reliability was evaluated through common coding of twenty responses, discussion, and revision of minor disagreements. One author coded remaining responses.

IV. RESULTS

A. Entrepreneurial Self-Efficacy

Simple confirmatory factor analysis for each scale on the pre-course data confirmed that scales from the McGee et al. [19] are likely effective for the population sampled in this study, although the small sample size limited further analysis. Based on these results. Score averages were calculated for matched pre and post-course surveys (n=44). All scores, except for Attitude, were higher on the post-survey, than on the pre-survey. Paired t-tests indicated that Search and Planning post-survey scores were statistically higher than the pre-survey scores ($p < 0.05$). Calculation of effect size as Cohen's d based on sample means indicates a medium effect size (Search $d = 0.372$; Planning $d = 0.476$). The medium effect can be interpreted to mean that this difference would be observable in a normal research study.

A factor analysis was undertaken to determine if the individual ESE scores related to a single overarching construct. One factor was extracted after four iterations, suggesting that a single ESE score could be calculated as the average across the five construct subscores. A paired t-test indicates that this average ESE score increases statistically from pre to post-course instruction ($p < 0.05$).

A linear regression was run to evaluate the influence of student variables on Search ESE, Planning ESE, and average ESE (Table 3). About 20% of the variance in post-instruction scores is attributable to participant variables, including pre-course scores, participant and familial entrepreneurial experience, and demographic variables. Pre-course Search and Average ESE scores account for 11-17% of the variance in post-course scores, with an additional 9% of the variance in both models explained by prior or familial entrepreneurship experiences and participant age. Alternatively, variance in post-course Planning ESE scores are not explained by pre-course scores; rather, ~20% of the variance in post-Planning ESE is attributed to participant demographic variables. Finally, 17% of the variance in post-course average ESE is explained by pre-scores, with the remainder of the variance in these scores being attributed to either the treatment (i.e., instruction) or variables not measured in this study.

TABLE 3. Regression Analyses for Post-Instruction Self-Efficacy (ESE)

Variable	Search		Planning		Average	
	B	β	B	β	B	β
Pre-ESE	.354	.374*	.003	.003	.297	.375*
Familial Exp.	.129	.093	.058	.044	-.020	-.020
Previous Exp.	-.213	-.116	-.354	-.203	-.278	-.209
Gender	-.122	-.084	-.347	-.252	-.228	-.217
Age	-.230	-.219	.255	.255	.114	.146
Major	-.031	-.034	-.040	-.046	.035	.051
Ethnicity	.078	.047	-.367	-.232	.031	.024
R ²	.200		.217		.260	

* $p < 0.05$

B. Entrepreneurial Behavior

Simple confirmatory factor analysis failed to confirm the four behavioral scales identified by Lau et al (2012). Although the sample is small, this result suggests that further analysis of the validity of this scale for this population is warranted. As a preliminary analysis, behavioral scores for pre- and post-course surveys were computed; a paired t-test indicated no statistical significance between the two tests ($p = .401$).

These results suggest one of two possibilities: 1) the curriculum does not impact student behavior; or 2) the scale is not a valid measure of behavior for this population. A new scale may be needed to adequately measure behavior aligned with the behaviors targeted by the Lean LaunchPad Curriculum.

C. Knowledge

Thirty-nine (39) and 35 of the 44 participants completed the open-ended knowledge questions in the pre-course and post-course surveys, respectively. Each question was analyzed with respect to student pre and post-course

responses. The four questions were framed with the following statement: "Your company has a new idea for a cellphone app to help people manage their diabetes. Please answer the following questions to the best of your ability."

a) *You have been tasked with evaluating whether or not this app should be brought to market by the company. Describe who you would speak to, why you want to speak to these people, and how you would make contact with them?* Overall, most students entering the course indicated that they would talk to diabetics and health care providers to "see if there is a need for [the app]." In post-course responses, respondents broadened their pool of potential interviewees to evaluate the market potential of the app. This included getting information on potential competitors and feedback from potential investors and technology developers (Table 4).

TABLE 4. Student Responses of Who Should be Contacted When Evaluating if a Product Should be Taken to Market

Who should be contacted?	
PRE (N=39)	POST (N=35)
Diabetics (32/39) = 82%	Diabetics (26/35) = 74%
Healthcare Providers (11/39) = 28%	Healthcare Providers (8/35) = 23%
Technology Specialists (4/39) = 10%	Technology Specialists (5/35) = 14%
Business Advisors (4/39) = 10%	Business Advisors (1/35) = 2.9%
Marketing (2/39) = 5%	Marketing (4/35) = 11%
Other (9/39) = 23%	Other (13/35) = 37%

Post-course survey responses also demonstrated that students were beginning to adopt the vocabulary from the Business Model Canvas. An example of this can be seen when comparing the following pre and post-course survey responses of a single respondent:

Pre-course response: *"I would speak with many different people who have diabetes and could benefit from our app that helps them manage their diabetes. I would speak with these people because this is our target audience as these are prospective users of our app."*

Post-course response: *"I would develop multiple teams to research the customer segment and value proposition of the app. Next, after finding the value prop. I would complete multiple assessments through customer discovery created by the teams to decide whether the product has value and will be profitable."*

Post-course survey responses also indicated that students were re-adjusting their approach to reaching out to diabetic patients. In the pre-course survey, students proposed reaching out to diabetics through healthcare professionals directly; however, in the post-course survey, more students indicated that they would attempt to speak with a diabetic in person, and fewer students mentioned contacting diabetics through healthcare providers.

b) *An elderly woman is having trouble managing her diabetes. Describe at least five steps you would take to determine if this cellphone app would be a potential solution for her problem.* A comparison of pre and post-course survey data indicated that students were more likely to conduct a patient trial as one of their top five steps after taking the Lean LaunchPad course. Some students also appeared to have

adopted the language of the Lean LaunchPad curriculum by speaking specifically about needing to better understand customer's "pain points". However, students' primary concerns remained fairly stable. Questions posed by students included: does the elderly person own a phone, how do they use their phone, are they comfortable with it? Also, how does the elderly person currently manage their diabetes? Moreover, post-survey course data suggests that students would like to understand the particular issues that the diabetic patient is experiencing with their current diabetes management system, products or strategies being used to manage their diabetes, and patient recommendations for how to solve their problem with diabetes management. These questions suggested that students were attempting to develop a clear understanding what customers need and how their product can be used to address those needs.

c) *In speaking with potential users, you discover that the majority of diabetic patients are over the age of 60. Describe how this might influence your company's next steps with the app.* Although the majority of students' pre and post-course survey responses indicate that they would modify the application to make it more user friendly (e.g. increasing font sizes, simplifying the user interface etc.), after taking the Lean LaunchPad course, more students indicated that they would be interested in testing the effectiveness of the application before proceeding with application production. However, it is interesting to note that the percentage of students who would conduct customer research did not change (11%). Recognizing the customer discovery process as iterative, one would assume that more students would be inclined to conduct customer research of their target audience. This could be indicative of a gap in student understanding the of the customer discovery process.

d) *Your company tasks you with putting together a team of people to make a final decision about bringing the app to market. Describe who would be on your team and how you would help ensure that the team would be successful.* In considering who students would include on their team to make a final decision about next steps for the app, the percentages of students who would recruit a technology specialist and a marketing person switched. The percentage of students who would recruit healthcare professionals essentially remained the same. Students interested in having a financial specialist on the team increased slightly, as did interest in having a diabetic person, and business advisors. (Table 5).

Table 5. Team Composition to Make Final Decision on the App

Team to Make Final Decision About the App	
PRE (N=34)	POST (N=35)
Marketing Team (21/34) = 62%	Technology Specialist (21/35) = 60%
Technology Specialist (18/34) = 53%	Marketing Team (19/35) = 54%
Healthcare Professionals (13/34) = 38%	Healthcare Professionals (13/35) = 37%
Finance Team (9/34) = 26%	Finance Team (11/35) = 31%
Diabetics (9/34) = 26%	Diabetics (11/35) = 31%
Business Advisors (2/34) = 5.9%	Business Advisors (5/35) = 14%

While the team compositions did not necessarily change significantly between the overall analysis of pre and post-course surveys, several student descriptions of the roles were more defined as represented in the following responses from one respondent:

Pre-course response: *"I would have people from each department who have been working on the app so I can get input from each respective point of view. This way you can cover most of your bases."*

Post-course response: *"I would bring in a person from each sector of business. I would have multiple researchers who have interacted with potential customers and know their needs/wants best. I would also have a person in charge of the financial side of things to help us understand the total cost this app would cost the company. Also, I would have an engineer who is in charge of deciding how the app is laid out and how it runs to answer any final questions about the app. I would ensure that the team goes over all aspects of the launch and projections for the first year, then how the app would grow with new users or potential technology changes."*

Post-course survey responses also suggested that several students saw their role as the facilitator of communication between team members, whereas pre-course data suggested that students may have relied on their experiences with group work to determine what they would do to ensure that their team would be successful. For instance, in the pre-course survey, students indicated that they would employ strategies such as weighing the pros and cons of launching the app, setting timelines, and delegating tasks. However, in the post-survey, students discussed the importance of facilitating communication between team members and synthesizing the information gathered by the team in order to make an informed decision about launching the app.

V. DISCUSSION

The Lean LaunchPad curriculum is a unique approach to entrepreneurship education, taking a step away from the more common approaches of business plans, intellectual property, and business fundamentals. It uses an active learning approach—customer discovery—to business model generation. Given the rapid adoption of this curriculum and its unique features, more exploration of its impact on students is warranted.

In this study, outcomes were studied in the framework of social cognitive theory[23]. This framework was chosen because of its emphasis on behavior, particularly because an objective of entrepreneurship education is to encourage entrepreneurial behavior from the individual students. According to social cognitive theory, self-efficacy effects the motivation and the ability for individuals to engage in certain behaviors [23]. Three variables were studied, attitude (ESE), behavior (entrepreneurial behavior), and knowledge (entrepreneurial knowledge).

One of the most commonly used psychological theories to explain human behavior is Ajzen's Theory of Planned Behavior, TPB [24]. TPB is an extension of Fishbein and

Ajzen's Theory of Reasoned Action [25]. According to the Theory of Reasoned Action, if individuals have a positive attitude towards a specific behavior (attitude) and they believe that their significant other supports them in that behavior (subjective norm), then the individuals are more likely to be motivated (intent) to go through with that specific behavior. In 1982, Ajzen broadened the Theory Reasoned Action to include the individuals' perceived behavioral control, the individuals' confidence in ability to perform a behavior, as an influencer of intent, resulting in the TPB. According to TPB, human behavior is a function of 1) an individual's attitude toward a behavior, 2) subjective norms, and 3) the individual's perceived behavioral control. In 1996, Kolvereid [26] demonstrated that TPB can be used to predict employment status choice intention. Entrepreneurial intent has since been a commonly used metric for predicting future entrepreneurial behavior.

Perceived behavioral control stems from Bandura's self-efficacy theory[23]. Self-efficacy theory comes from social cognitive theory and is considered the most important variable for behavioral change. In this study, two different measures were used to study entrepreneurial behavior, McGee's ESE measure and Lau's entrepreneurial behavior inventory. These two measures were used because they had been studied for validity and reliability within their sample sets. McGee's ESE was validated across entrepreneurs at varying levels and ages, while Lau's entrepreneurial behavior inventory was validated for executive MBA students who were experienced managers. The purpose of these studies were to not only measure student ESE and behavior, but to confirm that these measures are valid for undergraduate entrepreneurship students. While entrepreneurial intent has become a common analogue of behaviour, the entrepreneurial behavior inventory was chosen in an attempt to identify a direct measure of student behavior as opposed to relying on analogue.

ESE results suggested that McGee's ESE measure can be used to measure undergraduate ESE. The five constructs of ESE (search, planning, marshalling, implementing-people, and implementing-finances) proved to be effective measures for ESE in the context of studying the Lean LaunchPad Curriculum. Results indicated that students had statistically higher ESE scores for searching and planning, but not marshalling and implementing. Linear regression analysis for both Search and Planning confirmed that exposure to the Lean LaunchPad course did influence students' ESE to some extent. These results are consistent with the material delivered in the Lean LaunchPad curriculum. The curriculum focuses on customer discovery as opposed to execution, which would require (marshalling and implementing). These results suggest that students are becoming more comfortable with the search and planning phase of entrepreneurship and depending on the learning objectives of the course, could afford more direction with regard to execution.

Results from the entrepreneurial behavior inventory were less conclusive, suggesting that the selected scale is not an appropriate scale for measuring entrepreneurial behavior in undergraduate students. While the current sample was small, simple confirmatory factor analysis failed to confirm the four behavioral scales identified by Lau et al (2012) and behavioral

scores for pre- and post-surveys indicated no statistical significance between the two tests ($p=.401$). This is likely due to the fact that the inventory questions were in the context of how respondents would approach challenges met by employees in a business environment. While students were given instructions to "*Imagine you are working for a Fortune 500 company in a managerial role, respond to each of the following questions on how you would resolve issues that may arise,*" undergraduates' previous work experiences, or lack thereof, may have limited their ability to answer the questions effectively. These results suggest that researchers may consider developing a specific undergraduate, nascent entrepreneur, behavioral inventory for future studies.

Finally, very few researchers have been able to study knowledge gained from engineering entrepreneurship programs, largely due to the fact that entrepreneurship program curriculums are diverse and inconsistent across programs. The newness of the Lean LaunchPad program has limited research investigating student learning as a result of exposure to the Lean LaunchPad curriculum. The pilot survey implemented in this study attempted to capture student understanding of entrepreneurial practices before and after taking the Lean LaunchPad class. Qualitative analysis suggested that while incoming students do have a sense of the need to connect with potential customers to validate the need for a new product or service, students develop a more definitive vocabulary when discussing product conception and development and broaden their conceptualizations of the product development process. Given the preliminary nature of these studies, it is clear that more research can be done to examine student knowledge structures before and after enrolling in a Lean LaunchPad course.

There are several ways to improve the survey design. The current study also asked students to respond to several questions at once (i.e. Question 1: who would you talk to, why, and how would you reach them). Separating these questions to ensure that students respond to each component may have been more effective.

One way to improve the qualitative component of the study design is to analyze student responses to a structured class assignment. For example, students could submit an annotated approach to developing their business model, including their original hypotheses and customer discovery influences the evolution of their business model. Key aspects of the annotated approach might be profiles of recommended customer segments, a discussion of information gathering processes for potential customers, and specific strategies that the student would employ to ensure the validity of their assessment. Students who have not been exposed to Lean LaunchPad curriculum would complete the same assignment and results would be compared.

Another approach could include having students write reflections at multiple points during the semester to better understand how their understanding of the customer discovery process evolves during the course. Alternatively, if the qualitative component of the survey were to remain the same, an expert novice study could be performed, where student data could be compared to responses from experienced entrepreneurs. Interviews with students to supplement the

survey data could also be a useful next step, to see if students demonstrate additional understanding of Lean LaunchPad concepts.

This study provides the initial foundation for future, comprehensive studies examining the impact of the Lean LaunchPad curriculum. Unlike other course assessments, this approach not only studies knowledge creation, but the influence of curriculum on student self-efficacy, intent, and behavior.

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