AC 2012-3049: FACULTY BELIEFS OF ENTREPRENEURSHIP AND DESIGN EDUCATION: AN EXPLORATORY STUDY COMPARING ENTREPRENEURSHIP AND DESIGN FACULTY

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Faculty Beliefs of Entrepreneurship and Design Education: An Exploratory Study Comparing Entrepreneurship and Design Faculty

Abstract

Engineering capstone design and certain entrepreneurship courses have some similarities in terms of student outcomes, course structure, and instructional methods. Both types of courses have the tendency to be less structured than traditional courses and utilize teaching methods such as problem-based or project-based learning. The goals relating to the professional skill set are often similar and can include communication, writing, business, and team skills. Entrepreneurship instructors often focus on the development of the "entrepreneurial mindset" while design instructors focus on the development of "design thinking," characteristics that have some similarities. The role of the teacher in both areas is less likely to be a lecturer, but rather as a coach or a guide that assists students in completing a longer-term project. Many capstone courses have an industry component and can even have an entrepreneurial component. The purpose of this paper is to compare the teaching beliefs and practices of instructors of capstone design courses and entrepreneurship courses. The following research questions will be used to compare the beliefs of capstone versus entrepreneurship instructors:

1. What are the teaching practices of senior design versus entrepreneurship instructors?
2. How do instructors feel that entrepreneurship should be taught at the university to engineering students?
3. Do faculty members believe that the entrepreneurial mindset is something that can be developed or is it innate?

A total of 37 instructors of capstone design courses and engineering entrepreneurship courses at three large public institutions were invited to participate in an online survey. The preliminary results show some interesting similarities and differences between the two groups of instructors. Both groups reported using similar teaching practices, with student-led presentations, mentoring and coaching students, use of personal experiences, and guest speakers as the most frequently used techniques in their courses. Regarding the nature of the entrepreneurial mindset, entrepreneurship educators were more likely to believe that the necessary characteristics to be an entrepreneur are mostly developed; capstone design instructors were more likely to feel these characteristics were innate. While this may not be surprising given the fact that entrepreneurship instructors are teaching students the necessary skills to become an entrepreneur, this finding can have implications for other faculty when advising students on which courses or minors to explore.

Introduction and Background

According to the National Academy of Engineering, the future engineer will be "…broadly educated, see themselves as global citizens, can lead in business and public service, as well as in research, development and design, are ethical and inclusive of all segments of society. The attributes [of the future engineer] include strong analytical skills, creativity, ingenuity,

professionalism, and leadership" (p. 59).[1] The Obama administration has also provided a model for the future engineer, focusing on the ability to be innovative and creative. As President Obama stated in January, 2011, "The first step in winning the future is encouraging American innovation. None of us can predict with certainty what the next big industry will be or where the new jobs will come from…What we can do, what America does better than anyone else, is spark the creativity and imagination of our people."

As a result of the global changes necessitating the development of engineers with the aforementioned attributes, the curricula for engineering programs across the country have been modified in various ways. These modifications have primarily been made in order to create engineers who are more effective in the workplace and ready to meet the global challenges ahead of us. For example, in the past two decades, many engineering schools have made changes to the curriculum to add more courses in both engineering design[2] and entrepreneurship.[3] Most schools have implemented design courses at both the freshmen and senior levels, to give students the opportunity to practice engineering design skills. Entrepreneurship programs, in the form of certificate programs and minors, as well as stand-alone courses, have been initiated in many universities and colleges across the country.

Both entrepreneurship and engineering design are being studied extensively by engineering education researchers. As the study of these domains develops, researchers need to define the goals and objectives of these disciplines and build pedagogical models to guide instructional practice, a point that Fiet and Mars made about the state of entrepreneurship education.[4, 5] Part of developing pedagogical models of a domain includes understanding faculty beliefs and perceptions about that domain. Educational research has long supported a relationship between faculty perceptions and instructional practices.[i.e., 6, 7] This paper begins to uncover faculty beliefs in two areas of engineering education: entrepreneurship and design. The primary focus of this research is on faculty perceptions of entrepreneurship with the intent to quantify how faculty believe that entrepreneurship should be taught. This evaluation is based on the perceptions of faculty and instructors who have been tasked to teach entrepreneurship and those teaching in a very similar domain, engineering design.

While not often compared directly in the engineering education literature, the goals and practices in teaching engineering design have a strong parallel to the goals and practices of teaching entrepreneurship to engineers. Regarding educational goals, design courses often focus on development of "design thinking"[2] while entrepreneurship courses may focus on the development of the "entrepreneurial mindset."[8] When comparing the characteristics of each of these, there are some strong parallels. Dym, et al. defined "design thinking" as "a systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or process whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints" (p. 103). The authors go on to describe characteristics associated with the proficient designers, including tolerance for ambiguity, ability to see the "big picture," handle uncertainty, make design decisions, think in a team, and communicate in the language of design. Design thinkers also need to be able to think creatively, using divergent and convergent thinking. Atman et al. defined design thinking in a similar manner: "Design involves ambiguity, the existence of multiple solutions..., and a lack of procedural and declarative rules. Design is situated in real contexts, involves social processes, and involves

people with different perspectives (designers, non-designers, users, clients, etc.) from different disciplines within and outside of engineering, working together to solve complex technological problems that address societal as well as consumer needs."[9] In Atman's study, design experts rated the most important design activities as understanding the problem, identifying constraints, communicating, brainstorming, and seeking information. Fry stated that the characteristics of a design thinker include high tolerance for ambiguity, curiosity, and being a visual thinker.[10]

The definition of "design thinking" has some similarities to the "entrepreneurial mindset." For example, Bilén, et al. defined the skills associated with the entrepreneurial mindset as being risk taking, motivation, leadership, innovation, customer orientation, communication skills, teamwork, and business skills.[8] Kriewall, summarizing a panel at the 2010 annual conference of the National Collegiate Inventors and Innovators Alliance, defined the characteristics of the entrepreneurial minded engineer as possessing "integrity, tenacity, ethics, creativity, intuition, a deep knowledge of engineering fundamentals, the ability to engineer products for commercialization, a penchant for lifelong learning, and ability to see how their ideas fit into the larger context of society, and a proficiency in communicating his or her ideas."[11] Gurol and Atsan defined the "entrepreneurial profile" of students as high need for achievement, inner locus of control, a risk-taking propensity, high tolerance for ambiguity, innovativeness, and high self-confidence.[12] Okudan and Rzasa defined the necessary attributes of an entrepreneur as being autonomous, innovative, risk-takers, and competitive.[13]

There are some key differences in entrepreneurship education and engineering design regarding student goals. While not focusing on engineering education, Matthews described major differences in creative thinking, design thinking, and entrepreneurship.[14] Matthews defined entrepreneurship as a combination of creative and design thinking plus commercialization or exploitation. As she stated, "Some of the interesting differences between design and entrepreneurship are the focus on collaboration with multifunctional team and customers, active experimentation and development of prototypes in problem solutions. Design situations may not express all the components of entrepreneurial orientation but certainly are innovative, proactive, requiring and respective autonomy and risk taking, but may lack competitive aggressiveness" (p. 1164). While a focus on commercialization may not be inherent in most design instruction, there are certainly some parallels in the student goals between entrepreneurship and design.

The instructional practices for teaching entrepreneurship and design also have parallels. Active learning, case studies, project-based learning, and problem-based learning have often been used as strategies to teach entrepreneurship.[13, 15-17] These same instructional strategies, particularly project-based and problem-based learning, have often been used in teaching engineering design.[2] Both domains have used simulated realism to recreate the experiences of a real entrepreneur or a designer in industry.[13, 18] Design courses can sometimes have an entrepreneurial component as well.[19]

Both entrepreneurship and design education also have implementation challenges. Both may be viewed by some as being less central to the engineering curriculum, "Design faculty across the country and across a range of educational institutions still feel that leaders of engineering departments and schools are unable or unwilling to recognize the intellectual complexities and resources demanded to support good design education."(p. 103).[2] Both entrepreneurship and

design have been subjected to debates on whether they can be taught.[18, 20, 21] In addition, both have been thought to be difficult to assess, with some disagreement as to what constitutes the theoretical underpinnings. For example, as Heywood noted regarding design, "Among the major objections that design has had to overcome…is that design does not lend itself to objective assessment and that there is no theoretical basis for design education" (p. 285).[18] The same argument has been made by some practitioners regarding entrepreneurship as suggested by Fiet and Mars.[4, 5, 22]

With these strong parallels between student goals, instructional practices, and instructional challenges, comparing faculty beliefs of design and entrepreneurship instructors is of interest. Following up on earlier research examining faculty beliefs of entrepreneurship faculty members and instructors, we decided to survey both groups.[23, 24] This study had two foci: First, we wanted to examine faculty beliefs and practices in entrepreneurship versus those in engineering design. We asked questions of faculty concerning their teaching practices and the ideal instructor in their domain. Second, we wanted to gather faculty beliefs regarding how they felt entrepreneurship should be taught to students. Did faculty in both domains feel that entrepreneurship could be taught? Specifically, what attributes of entrepreneurship did they feel were more likely able to be taught versus those they felt were more inherent to personality?

The following three research questions were examined:

1. What are the teaching practices of senior design versus entrepreneurship instructors?
2. How do instructors (both entrepreneurship and design) feel that entrepreneurship should be taught at the university to engineering students?
3. Do faculty members (both entrepreneurship and design) believe that the entrepreneurial mindset is something that can be developed or is it innate?

Using surveys of both entrepreneurship and design faculty and instructions at three large research universities, these areas were explored.

Methods

This study was completed in two phases. In phase 1, the *Entrepreneurship Faculty Beliefs Survey* was administered to faculty and instructors who were associated with entrepreneurial programs or had experience teaching entrepreneurship-related courses at their respective institutions. In phase 2, the *Educators' Beliefs Regarding Teaching Survey* was administered to instructors of capstone design courses at selected institutions. Specifically, all data was collected from faculty and instructors at three partner institutions, which are large research-oriented universities located in the Mid-Atlantic, Midwest, and Southern states. The responses from the survey were analyzed using quantitative data analysis techniques.

Participants. Survey response data was collected from 56 faculty members from the three partner institutions. Of the faculty members surveyed, 37 taught or are currently teaching entrepreneurial courses and 19 taught, or presently teach, engineering capstone design courses. Faculty members who were associated with the targeted programs, or had experience teaching entrepreneurship or capstone courses-related at those institutions, were asked to participate. More male (80%, N =

44) than female (20%, *N* = 11) faculty members were surveyed across the institutions. There were no appreciable gender ratio differences between the entrepreneurship and capstone faculty.

The departmental membership status most frequently cited by the entrepreneurial faculty respondents was related to management, engineering, or entrepreneurship. Of these respondents, 13 were from engineering fields, 9 from business, 6 from primarily entrepreneurship programs, and 7 from other areas (information sciences and technology, forestry, graphic and industrial design, outreach, or an administrative office). All of the capstone design faculty who responded listed their respective departments as engineering-related. Figure 1 graphically displays the type of positions held by the respondents. The entrepreneurship faculty members who responded to the survey indicated that they had the following roles: *Full Professor* (17%, *N* = 6), *Associate Professor* (17%, *N* = 6), *Assistant Professor* (19%, *N* = 7), and *Instructor* or Lecturer (28%, *N* = 10). Research Associate was the most frequent response to the option *Other* (11%, *N* = 4). There was a greater percentage of design faculty who reported being *Full Professor* (44%). A total of 22% reported being an associate professor. Slightly more than a third of entrepreneurial faculty respondents identified themselves as tenured or on the tenure track (36%, *N* = 13) while 50% (*N* = 9) of the capstone design faculty indicated they were tenured or on the tenure track, as shown in Figure 2.

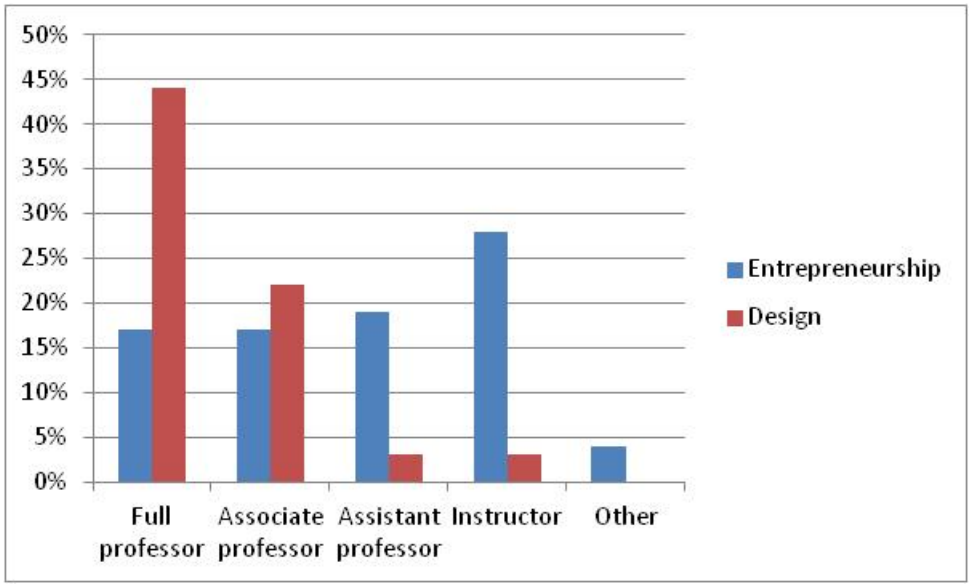

Figure 1: Type of position held by survey respondents

Eighty six percent (*N* = 30) of the entrepreneurial faculty members surveyed had worked for a small start-up company, which is slightly greater than the percentage of engineering capstone design faculty who reported that they had worked for a small start-up company (73%, *N* = 8). Roughly than half of entrepreneurship faculty (57%, *N* = 20) and capstone faculty (55%, *N* = 6) had worked in an "innovation" segment of a large company. Approximately two-thirds of the entrepreneurial faculty (63%, *N* = 22) and capstone faculty (67%, *N* = 12) denoted they held patents. This data is displayed graphically in Figure 3.

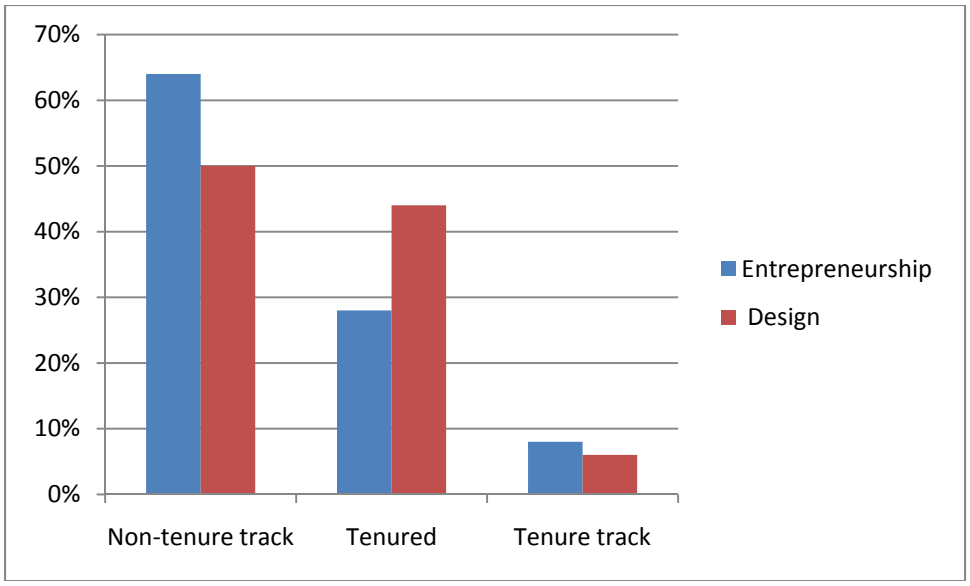

Figure 2: Position types for respondents

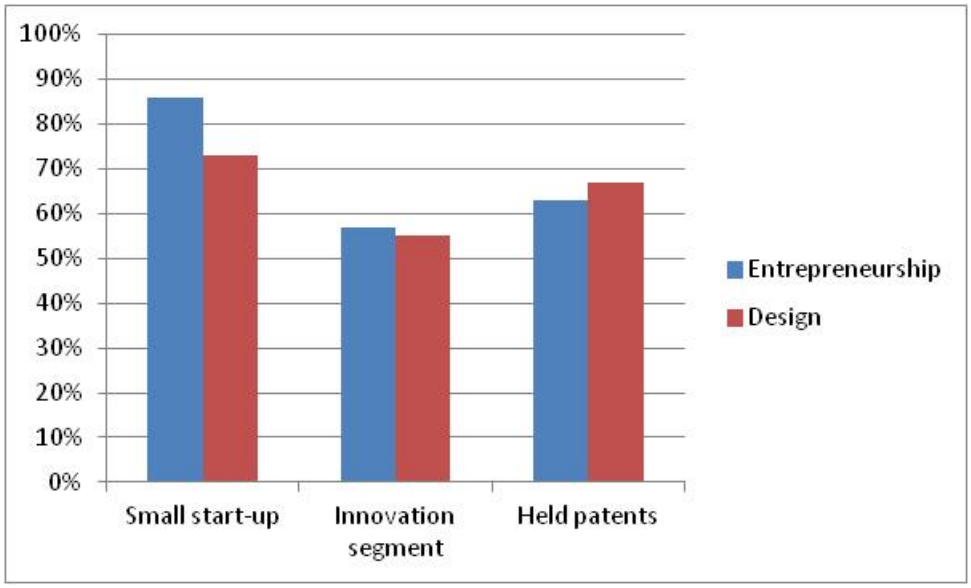

Figure 3: Prior experiences of survey respondents

The majority of the entrepreneurial faculty respondents considered themselves to be entrepreneurs (84%, $N = 31$). When provided the following options, and asked to select all that apply, engineering capstone design faculty respondents indicated they considered themselves to be: a teacher (100%, $N = 19$), an engineer (84%, $N = 16$), a researcher (68%, $N = 13$), an innovator (58%, $N = 11$), an entrepreneur (37%, $N = 7$), or an inventor (26%, $N = 5$).

Entrepreneurship Faculty Beliefs Survey – Entrepreneurship Instructors. The first iteration of the faculty belief survey was developed in fall of 2009 in an effort to investigate how instructors of entrepreneurship (a) define the entrepreneurial mindset, or the characteristics necessary to be

an entrepreneur; (b) if they believe that the entrepreneurial mindset is innate, can be developed, or both; (c) and if there is a relationship between faculty beliefs and entrepreneurial teaching methods. Specifically, the purpose of the survey was to collect information to determine how variation in faculty entrepreneurial beliefs may influence their respective pedagogy. The initial survey was constructed based on a qualitative analysis of interview data garnered from entrepreneurial faculty during of this study.[23] Expert feedback from an advisory board, and from other faculty members who teach entrepreneurship, was used to refine the preliminary versions of the survey.

The survey contains 19 core questions, as well as 14 demographic items, and 3 items concerning ethical issues. Item-types utilized in the survey vary. Survey item-types include: multiple response, Likert-type scale, brief response, and rank order items. Innovative item-types include "sliders" or sliding scale items. Examples of sliding scale items are provided in Figures 4a and 4b, shown in the appendix. A sliding scale question is answered by moving an indicator marker or "slider" along an axis that represents the continuum between two, typically divergent, constructs. Another interactive item-type involves an item sorting task whereby the examinee sorts, or groups, items by dragging and dropping them into boxes representing different constructs. The final version of the entrepreneurship education survey was administered during fall of 2010.

Educators' Beliefs Regarding Teaching Survey – Design Capstone Instructors. The results from the *Entrepreneurship Faculty Beliefs Survey* were considered in the development of the *Educators' Beliefs Regarding Teaching Survey*. The survey contains 16 core questions and 8 demographic items. Several items for the *Educators' Beliefs Regarding Teaching Survey* were similar to, and in some cases the same as, the *Entrepreneurship Faculty Beliefs Survey* to allow for direct comparisons between the two instruments. The questions asked about the participants' teaching practices as well as their perceptions of entrepreneurship and entrepreneurship education.

Data Collection Procedures. The *Entrepreneurship Faculty Beliefs Survey* was given during fall 2010. The *Educators' Beliefs Regarding Teaching Survey* was given in the summer of 2011. Both surveys were administered using Qualtrics,[25] which is an online commercial survey package. Faculty members were invited to participate in the survey based on either their relationship to an institution's entrepreneurship program or engineering capstone design courses. Potential participants were sent e-mail invitations reminding them to complete the survey from both fellow department faculty or program directors and the researchers conducting the investigation.

Using the trimmed mean to remove outliers, the average amount of time that the faculty respondents required to complete the *Entrepreneurship Faculty Beliefs Survey* was 36 minutes. The response rate was calculated by dividing the number of faculty who responded (partial and complete responses were included) by the number of faculty who were invited to participate. Of the 47 faculty invited, 37 responded yielding a total response rate of 79%. The trimmed mean for *Educators' Beliefs Regarding Teaching Survey* was 24 minutes; nineteen of the 50 faculty invited responded to the survey, which yielded a total response rate of 38%.

Data Analyses. The majority of the item response results were generated using the reports function in Qualtrics. Descriptive statistics, including frequency of response, central tendency information, and counts, were used to facilitate item response analyses. A project member analyzed the responses to open-ended questions by grouping them by similar content. Additionally, the aggregate faculty responses to the sliding scale items were represented by box plots. R statistical computing and graphics language[26] was used to generate these plots. It should be noted that statistical hypothesis testing could not be used to analyze the item response data due to sample size limitations

Results

1. What are the teaching practices of senior design versus entrepreneurship instructors?

The faculty participants were asked a series of questions regarding instructional methods in an attempt to determine how they teach entrepreneurship or senior design. When asked which strategies they use when teaching in their respective discipline, the majority of the faculty respondents specified that they have used most of the techniques listed when teaching. Entrepreneurial and senior design faculty selected *have students give presentations*, *mentor or coach students*, *my personal experiences*, and *have guest speakers* options most often. (See Table 1 for complete data.) Of note, entrepreneur-related and senior design faculty selected several options differentially. Specifically, considerably fewer design faculty selected *have students give elevator pitches* (47%, *N* = 9), *have students develop a business plan* (58%, *N* = 11), and *use technology teaching tools (i.e., clickers, podcasts, etc.)* (26%, *N* = 5) when compared to the entrepreneurship faculty (89%, *N* = 31; 83%, *N* = 29; and 46%, *N* = 16 respectively). Conversely, substantially more design faculty selected *have students practice (e.g., "trial and error")* (84%, *N* = 16) and *use textbooks* (74%, *N* = 14) than the entrepreneurship faculty (69%, *N* = 24 and 34%, *N* = 12).

The following questions were asked of only the senior design instructors as a follow up to the preceding instructional method question, "Which of the above do you feel are *most* important for students to understand senor design?" and "Which of the above do you feel are *least* important for students to understand senor design?" Specifically, the senior design instructors were to select three options for both *most* and *least* from the list provided in the previous question. The senior design faculty selected *have students develop a product plan, have students practice (e.g., "trial and error")*, and *mentor or coach students* as the most important options. The senior design faculty selected *my educational background*, *use textbooks*, and *use technology teaching tools (i.e., clickers, podcasts, etc.)* as the least important options.

Table 1: Responses to *"I use these when teaching. Select all that apply"*

Option	Entrepreneurship Instructors	Senior Design Instructors
	Percentage (Response Count)	Percentage (Response Count)
Have students give presentations	97% (*N* = 34)	100% (*N* = 19)
Mentor or coach students	94% (*N* = 31)	100% (*N* = 19)
My personal experiences	91% (*N* = 32)	100% (*N* = 19)
Have guest speakers	91% (*N* = 32)	89% (*N* = 17)
My passion	89% (*N* = 31)	79% (*N* = 15)
Have students give elevator pitches*	89% (*N* = 31)	47% (*N* = 9)
Use active learning	86% (*N* = 30)	89% (*N* = 17)
Have students develop a business plan*	83% (*N* = 29)	58% (*N* = 11)
My professional background	80% (*N* = 28)	79% (*N* = 15)
My drive	77% (*N* = 27)	74% (*N* = 14)
Use case studies	71% (*N* = 25)	63% (*N* = 12)
My educational background	69% (*N* = 24)	79% (*N* = 15)
Have students practice (e.g., "trial and error")*	69% (*N* = 24)	84% (*N* = 16)
Use technology teaching tools (i.e., clickers, podcasts, etc.)*	46% (*N* = 16)	26% (*N* = 5)
Use textbooks*	34% (*N* = 12)	74% (*N* = 14)

* Indicates response percentage difference for option was ≥15% points between Entrepreneurship and Senior Design Instructors.

To further distinguish any similarities or differences in entrepreneurial and senior design teaching beliefs, the following question was asked, "If you could define the characteristics of the ideal instructor in your discipline, what would these characteristics be? Select all that apply." Both the entrepreneurial and senior design faculty frequently selected *is passionate* and *is a mentor, facilitator, or "coach."* (See Table 2 for complete data.) The two groups of faculty tended to disagree somewhat on several characteristics as noticeably more entrepreneurship instructors than senior design faculty selected the following characteristics (entrepreneur and senior design responses listed respectively): *has experience being an entrepreneur* (89%, *N* = 31 and 68%, *N* = 13), *uses active learning techniques in the classroom* (89%, *N* = 31 and 68%, *N* = 13), *uses case studies or real life examples in the classroom* (83%, *N* = 29 and 58%, *N* = 11), and *uses technology tools in the classroom* (34%, *N* = 12 and 16%, *N* = 3).

Conversely, more senior design than entrepreneurial faculty selected the following characteristics (entrepreneurial and senior design responses listed respectively): *comfortable with taking risks* (63%, *N* = 22 and 79%, *N* = 15), *is outgoing* (31%, *N* = 11 and 79%, *N* = 15), and *is interested in social change* (26%, *N* = 9 and 47%, *N* = 9). It should be noted that one option was given only to the entrepreneurial faculty (i.e., *currently has entrepreneurial venture(s)*). (See Table 2 for complete data.)

The following question was asked of only the senior design instructors as a follow-up to the previous ideal instructor characteristics question, "Which of the above characteristics do you feel are most important for a senior design instructor to have?" The senior design instructor respondents most frequently selected: *is a mentor, facilitator, or "coach"* and *uses his or her life experiences as educational examples*.

It was anticipated that faculty teaching entrepreneurship or senior design courses might be confronted with various challenges while trying to implement the curriculum as the teacher's role in both disciplines tends to be less lecture-based. In an effort to further explore this issue, the faculty were given several options related to situations they may have encountered and asked, "Which of the following prove to be challenges when teaching in your discipline?" It was requested that faculty select all options that applied. Based on the percentage of faculty respondents selecting the provided options, a substantial proportion of the faculty surveyed had been confronted with various challenges within their respective disciplines. The most frequently selected option for faculty in both disciplines surveyed was *students' prior knowledge* (entrepreneurs: 52%, *N* = 17; senior design: 63%, *N* = 12). Of note, a markedly greater percentage of entrepreneurial (58%, *N* = 19) than senior design faculty (11%, N = 2) selected *the institution's bureaucracy.* Additionally, a higher percentage of senior design (58%, *N* = 11) than entrepreneurial (42%, *N* = 14) faculty selected *the different type of workload involved with teaching the subject matter*. It should be noted that one option was given only to the entrepreneurial faculty (i.e., *tenure and review policies do not recognize entrepreneurship*) and one option was given only to the senior design faculty (i.e., *ABET requirements*). (See Table 3 for complete data.)

Table 2: Responses to *"If you could define the characteristics of the ideal instructor in your discipline, what would these characteristics be? Select all that apply.*"

Characteristic	**Entrepreneurship Instructors**	**Senior Design Instructors**
	Percentage (Response Count)	Percentage (Response Count)
Is passionate	91% (*N* = 32)	79% (N = 15)
Has experience being an entrepreneur*	89% (*N* = 31)	68% (N = 13)
Is a mentor, facilitator, or "coach"	89% (*N* = 31)	95% (N = 18)
Uses active learning techniques in the classroom*	89% (*N* = 31)	68% (N = 13)
Uses case studies or real life examples in the classroom*	83% (*N* = 29)	58% (N = 11)
Uses his or her life experiences as educational examples*	77% (*N* = 27)	68% (N = 13)
Is driven	71% (*N* = 25)	63% (N = 12)
Has networking ability	69% (*N* = 24)	58% (N = 11)
Comfortable with taking risks*	63% (*N* = 22)	79% (N = 15)
Currently has entrepreneurial venture(s)	49% (*N* = 17)	See note.
Uses technology tools in the classroom*	34% (*N* = 12)	16% (N = 3)
Is outgoing*	31% (*N* = 11)	79% (N = 15)
Has international professional experiences	26% (*N* = 9)	16% (N = 3)
Is interested in social change*	26% (*N* = 9)	47% (N = 9)
Has environmental concern	26% (*N* = 9)	37% (N = 7)

Note. Option given to only one group of instructors
* Indicates response percentage difference for option was ≥15% points between Entrepreneurship and Senior Design Instructors.

Table 3: Responses to "*Which of the following prove to be challenges when teaching in your discipline?"*

Option	Entrepreneurship Instructors	Senior Design Instructors
	Percentage (Response Count)	Percentage (Response Count)
The intuition's bureaucracy*	58% (*N* = 19)	11% (*N* = 2)
Students' prior knowledge	52% (*N* = 17)	63% (*N* = 12)
The different type of workload involved with teaching the subject matter*	42% (*N* = 14)	58% (*N* = 11)
Budget constraints	42% (*N* = 14)	37% (*N* = 7)
Designing the course curriculum	30% (*N* = 10)	21% (*N* = 4)
Students' beliefs	27% (*N* = 9)	37% (*N* = 7)
How other colleges within the institution define or teach the subject matter	27% (*N* = 9)	32% (*N* = 6)
My department's learning objective for the course	3% (*N* = 1)	5% (*N* = 1)
Tenure and review policies do not recognize entrepreneurship (Note: Item given to entrepreneurship faculty only.)	18% (*N* = 6)	See Note.
ABET requirements (Note: Item given to senior design faculty only.)	See Note.	32% (*N* = 6)

Note. Option given to only one group of instructors.
* Indicates response percentage difference for option was ≥15% points between Entrepreneurship and Senior Design Instructors.

2. *How do instructors feel that entrepreneurship should be taught at the university to engineering students?*

To help determine what type of entrepreneurship instruction the entrepreneurial and senior design faculty participants thought engineering students should be taught the following question was asked, "If you were developing a new entrepreneurship program for undergraduate engineering students, what would you include? Select all that apply." Based on the response percentages some curricular components were viewed as more essential than others by the entrepreneurial and senior design faculty. Particularly, *capstone project*, *introductory entrepreneurship course*, and *development of a business plan* were frequently selected by both faculty groups. *Internship or practicum* and *global competitiveness element* were infrequently selected by both entrepreneurship and senior design faculty. (See Table 4 for complete data.) Response selection frequency discrepancies between the two faculty groups could be seen for the

following options (entrepreneur and senior design responses listed respectively): *capstone project* (97%, *N* = 34 and 79%, *N* = 15), *coursework on business skills* (89%, *N* = 31 and 68%, *N* = 13), *intellectual property course* (83%, *N* = 29 and 68%, *N* = 13), *entrepreneurship ethics modules and cases* (69%, *N* = 24 and 84%, *N* = 16), *innovative thinking course* (63%, *N* = 22 and 79%, *N* = 15), and *leadership training* (51%, *N* = 18 and 74%, *N* = 14). It should be noted that although some elements were more frequently cited than others, most of the options listed were selected by the majority of the faculty respondents.

Table 4: Responses to *"If you were developing a new entrepreneurship program for undergraduate engineering students, what would you include?"*

Option	**Entrepreneurship Instructors**	**Senior Design Instructors**
	Percentage (Response Count)	Percentage (Response Count)
Capstone project*	97% (*N* = 34)	79% (*N* = 15)
Introductory entrepreneurship course	89% (*N* = 31)	79% (*N* = 15)
Coursework on business skills*	89% (*N* = 31)	68% (*N* = 13)
Intellectual property course*	83% (*N* = 29)	68% (*N* = 13)
Development of a business plan	80% (*N* = 28)	89% (*N* = 17)
Formal mentoring program	71% (*N* = 25)	74% (*N* = 14)
Entrepreneurship ethics modules and cases*	69% (*N* = 24)	84% (*N* = 16)
Innovative thinking course*	63% (*N* = 22)	79% (*N* = 15)
Leadership training*	51% (*N* = 18)	74% (*N* = 14)
Internship or practicum	49% (*N* = 17)	42% (*N* = 8)
Global competitiveness element	40% (*N* = 14)	47% (*N* = 9)

* Indicates response percentage difference for option was ≥15% points between Entrepreneurship and Senior Design Instructors.

In an attempt to measure the faculty respondents educational practice views and beliefs with finer precision, a series of five slider items were employed. The respondents were asked to move a "slider" along an axis that signified the degree of distinction between a quality on the left side of the scale (represented by 0) and a quality on the right side of the scale (represented by 100) with neutral being represented by 50. (See Methods for detailed slider item description.) The goal of the items was to ascertain faculty perceptions regarding the ideal teaching methods for entrepreneurship. As such, the faculty respondents were asked to select a position for their responses along a continuum, with roughly opposing constructs listed at each end of the slider axes. The results for each item follows.

- The median value for the entrepreneurial and senior design faculty who responded to the item, "Entrepreneurship programs should focus on: *Venture* versus *Product Technology*

Innovation" was 50, which was indicative of essentially no difference between the two groups of faculty members' responses to this item. There was a slight tendency towards the *Venture* side of the scale for the entrepreneurial faculty responses as the average value was 42.91 ($N = 34$) while the mean for the senior design faculty was 52.58 ($N = 19$). (All boxplots are displayed in the Appendix. See Figures 4a and 4b.)

- The median value for the entrepreneurial and senior design faculty responses to the item, "Entrepreneurship programs should focus on: *Traditional Vision of Entrepreneurship* versus *Social Entrepreneurship*" was 50, which is evidence of essentially no difference between the two faculty members' responses to this item. (See Figures 5a and 5b for boxplots.)

- The item, "Entrepreneurship programs should focus on: *Intrapreneurship Only* versus *Entrepreneurship Only*" yielded a median value of 60, or towards the *Entrepreneurship Only* side of the scale, for the entrepreneurial faculty responses. There was a median value of 50 for the senior design faculty responses to this item, which was indication that their responses tended to fall between *Intrapreneurship Only* and *Entrepreneurship Only*. (See Figure 6a and 6b for boxplots.)

- The median response for the entrepreneurial faculty who responded to the item, "Entrepreneurship should be taught through: *Unstructured Experiences* versus *Institutionalized Programs*" was 70, indicating responses tended towards the *Institutionalized Programs* side of the scale. The senior design faculty median response was 60, which was slightly towards the *Institutionalize Programs* side of the scale. (See Figures 7a and 7b for boxplots.)

- Finally, the median entrepreneurial faculty response was 50 to the item, "The best way to learn entrepreneurial skills is through: *Out of Class Experiences* versus *Formal Class Experiences*." The median senior faculty response was 41 to this item, which indicated that their responses fell slightly to the *Out of Class Experiences* side of the scale. (See Figures 8a and 8b for boxplots).

Independent groups *t*-tests were conducted on each of the slider questions to determine if there were significant differences between the entrepreneurship and design faculty. Due to the small sample sizes, none of the above tendencies were found to be significantly different.

3. *Do faculty members believe that the entrepreneurial mindset is something that can be developed or is it innate?*

In an effort to quantify the degree to which the faculty members who participated in the present study believe that the entrepreneurial mindset is something that can be developed or conversely is innate, a sliding scale question was employed. The entrepreneurial faculty response median value to the item, "The necessary characteristics to be an entrepreneur are: *Mostly Innate or Inborn* versus *Mostly Developed or Learned*" was 70, which provided indication that these faculty respondents tended towards the *Mostly Developed or Learned* side of the scale. The entrepreneurial faculty average response value verified this result (64.35, $N = 25$). In contrast, the

senior design faculty response median value to this item was 35, which was on the *Mostly Innate or Inborn* side of the scale. The senior design faculty average response value supported this result (38.90, $N = 10$). (See Figures 9a and 9b for boxplot.) Additionally, an independent samples *t*-test was run. There was evidence of a significant difference between the entrepreneurial senior design faculty responses (*p*-value = .006, equal variances). However, there are two caveats to this finding. First, given the small sample size, the confidence that should be placed in the conclusion is low. Second, since *t*-tests were also run on the other five sliding scale questions, an adjustment was needed. A Bonferroni correction was made for the six sliding scale items $\alpha = .008$ (.05/6).

Another question was asked of the entrepreneurial faculty concerning innate versus developed characteristics. Specifically, the faculty participants were given a list of items and asked to differentiate between "more inherent to personality" or "more easily developed or learned" characteristics. Based on response counts, both entrepreneurial and senior design faculty frequently grouped *drive*, *outgoing*, *passion*, *curious*, *comfortable with ambiguity*, and *comfortable taking risk* as "more inherent to personality" (in descending order) based on response count. Both entrepreneurial and senior design instructors grouped *business skills*, *technical skills*, *problem solving ability*, *communication skills*, and *ability to learn from failures* as "more easily developed or learned" (in descending order) characteristics by response count.

There were some notable differences between the percentage of entrepreneurship and senior design instructors selecting various items. In particular, a substantially higher percentage of senior design instructors than entrepreneurship instructors selected the following items as "more inherent to personality:" *comfortable with taking risks*, *vision (i.e., can visualize a future state)*, *ability to adapt*, *ability to act on opportunities*, *interpersonal skills*, and *problem solving ability*. Of note, this difference was especially marked for *ability to adapt* as 94% ($N = 16$) of the senior design respondents selected it in comparison to the 41% ($N = 15$) of the entrepreneurship instructors who did. When asked to select the "more easily developed or learned" items, a notably greater percentage of entrepreneurship instructors than senior design instructors chose the following items: *comfortable with taking risks*, *vision (i.e., can visualize a future state)*, *ability to adapt*, *ability to act on opportunities*, *interpersonal skills*, and *problem solving ability*. (See Table 5 for complete data.)

Table 5: Responses to "*Indicate if the items listed to the left below are more inherent to personality or more easily developed or nurtured.*"

Item	Entrepreneurship Instructors		Senior Design Instructors	
	More Inherent to Personality	More Easily Developed or Learned	More Inherent to Personality	More Easily Developed or Learned
	Percentage (Response Count)	Percentage (Response Count)	Percentage (Response Count)	Percentage (Response Count)
Drive	**86% (*N* = 32)**	5% (*N* = 2)	**100% (*N* = 17)**	0% (*N* = 0)
Outgoing	**86% (*N* = 32)**	8% (*N* = 3)	**100% (*N* = 17)**	0% (*N* = 0)
Passion	**86% (*N* = 32)**	14% (*N* = 5)	**100% (*N* = 17)**	0% (*N* = 0)
Curious	**86% (*N* = 32)**	14% (*N* = 5)	**100% (*N* = 17)**	0% (*N* = 0)
Comfortable with ambiguity	**76% (*N* = 28)**	22% (*N* = 8)	**76% (*N* = 13)**	18% (*N* = 3)
Comfortable with taking risks	**62% (*N* = 23)**[a.]	32% (*N* = 12)[b.]	**88% (*N* = 15)**[a.]	12% (*N* = 2)[b.]
Vision (i.e., can visualize a future state)	46% (*N* = 17)[a.]	49% (*N* = 18)[b.]	**82% (*N* = 14)**[a.]	18% (*N* = 3)[b.]
Ability to adapt	41% (*N* = 15)[a.]	49% (*N* = 18)[b.]	**94% (*N* = 16)**[a.]	6% (*N* = 1)[b.]
Ability to act on opportunities	30% (*N* = 11)[a.]	**65% (*N* = 24)**[b.]	**65% (*N* = 11)**[a.]	24% (*N* = 4)[b.]
Interpersonal skills	30% (*N* = 11)[a.]	**70% (*N* = 26)**[b.]	59% (*N* = 10)[a.]	41% (*N* = 7)[b.]
Ability to learn from failures	24% (*N* = 9)	**70% (*N* = 26)**	29% (*N* = 5)	**71% (*N* = 12)**
Communication skills	14% (*N* = 5)	**86% (*N* = 32)**	18% (*N* = 3)	**82% (*N* = 14)**
Problem solving ability	8% (*N* = 3)[a.]	**92% (*N* = 34)**[b.]	24% (*N* = 4)[a.]	**76% (*N* = 13)**[b.]
Technical skills	3% (*N* = 1)	**97% (*N* = 36)**	0% (*N* = 0)	**100% (*N* = 17)**
Business skills	0% (N = 0)	**100% (*N* = 37)**	6% (*N* = 1)	**94% (*N* = 16)**

Note. Boldface values denote category with higher response count within instructor type.

[a.] Indicates response percentage difference ≥ 15% points between instructor types for "More Inherent to Personality" category.

[b.] Indicates percentage difference ≥ 15% points between instructor types for "More Easily Developed or Learned" category.

Summary of Survey Results

The list below summarizes the comparisons between entrepreneurship and design faculty:

1. Both entrepreneurship and design faculty report using student-led presentations, coaching of students, personal experiences in the classrooms, and guest speakers. When compared to design instructors, entrepreneurship instructors were more likely to use elevator pitches, business plans, and technology tools. Design faculty were more likely to use textbooks and have students practice.

2. Design instructors felt that student-developed product plans, opportunities to practice, and coaching of students were most important for students to understand design.

3. The ideal instructor of both entrepreneurship and design was reported by faculty to be passionate and a mentor or coach. Entrepreneurship instructors also felt that the faculty's experience of being an entrepreneur, use of active learning, case studies, and real-life examples were important. Senior design faculty felt that design instructors also need to be comfortable with taking risks and be outgoing.

4. Both groups of faculty cited students' prior knowledge as the biggest teaching challenge. Entrepreneurship instructors also felt that bureaucracy within the institution was a challenge of teaching. Design faculty felt that a challenge was the different type of workload involved with teaching design.

5. Overall, design faculty and entrepreneurship faculty had similar views on how entrepreneurship should be taught with both focusing slightly towards the traditional vision of entrepreneurship, and utilization of institutionalized programs.

6. An interesting difference between the groups concerned the perceptions on whether entrepreneurship is developed or learned. Entrepreneurship faculty were more likely to believe that entrepreneurship can be developed; design faculty were more likely to believe that the entrepreneurial mindset is innate.

Discussion

The purpose of this study was to begin to explore faculty and instructors' perceptions of entrepreneurship education, particularly comparing the responses of entrepreneurship versus design instructors. The primarily limitation of this study is the small sample size for each group, particularly the capstone design instructors which had only 19 respondents. Due to the small sample sizes and the descriptive nature of this study, in many cases, statistical tests were unable to be conducted to see if the differences in beliefs between entrepreneurship and design faculty were statistically significant. We view this study as exploratory, providing some general ideas where faculty beliefs may vary and need to be investigated more deeply. Further research may want to investigate these conclusions in more detail to see if they hold true with a larger sample. An additional limitation is that only three schools participated in this study, all being large,

public institutions. The faculty beliefs of instructors in the areas examined may differ at smaller institutions.

The teaching practices of senior design and entrepreneurship instructors were quite similar. Presentations, coaching or mentoring, using personal experiences, and including guest speakers were all similar strategies incorporated into courses in both areas. Not surprisingly, the instructors of entrepreneurship courses had a greater tendency to require students to give elevator pitches and develop a business plan. Design faculty were more likely to require students to practice (using trial and error) and include textbooks in their course. Neither groups of faculty tend to use technology tools often, perhaps due to the relatively small class sizes typical of both entrepreneurship and design courses.

Regarding the ideal instructor in the respective disciplines, entrepreneurship versus capstone design, faculty reported both similarities and differences. As anticipated, entrepreneurship instructors were more likely to include experience being an entrepreneur as an ideal characteristic, although the design faculty rated this fairly high as well. One unforeseen result was the percentage of design instructors who stated that the ideal design instructor should have comfort in taking risks; this percentage was slightly higher than for entrepreneurship educators. It is important to note that approximately one third of the design instructors considered themselves to be entrepreneurs, even though they did not teach in the entrepreneurship minor in their discipline. It is possible that their background as entrepreneurs may influence their beliefs regarding how senior design should be taught.

Another similarity of design and entrepreneurship courses is the type of challenges that these instructors perceive while teaching. Both perceived that teaching their type of course has a different, and perhaps more extensive, workload than other types of courses. Both identified that students' prior knowledge provides a unique challenge to teaching. Although we did not specifically follow-up with the participants to see how prior knowledge presents a challenge, we can hypothesize that instructors either feel that students come in with certain misconceptions or that they are not prepared to take on the work in the course. Further investigation into better understanding the perceived challenges of teaching in these areas would be necessary to better understand how students' prior knowledge influences teaching.

Instructors of entrepreneurship and design also had similar beliefs in how they felt that entrepreneurship education should be approached, with some minor differences. For example, entrepreneurship faculty were more likely to denote that they would include a capstone project, and coursework on business skills and intellectual property. Design faculty were more likely to indicate that they would include information on ethics, innovative thinking, and leadership. One possible reason for the slight response differences is that the design faculty might be less likely to include a capstone project, as they are teaching a capstone project themselves in the senior year. Other reasons for possible differences are not clear.

The sliding scale questions in the survey asked participants to move a slider to indicate how they felt entrepreneurship should be taught. For several items, the results were not informative as the median was 50. Because so many individuals selected 50 as their response, the median or middle score of the distribution was also often 50. A score of 50 may indicate that the respondent felt that he or she could not make a judgment or that both options would be suitable. This was the case for the items asking the instructors to state whether they felt that entrepreneurship

programs should focus on venture versus product technology and traditional versus social entrepreneurship (Figures 4a and 4b, 5a and 5b). However, it was clearer that both groups of faculty believed that entrepreneurship should be taught through institutionalized programs as compared to unstructured experiences (Figure 7a and 7b).

Perhaps the most surprising result of this study is the comparison of faculty's perception of whether they felt that the necessary characteristics of entrepreneurship were thought to be learned or innate. The design instructors who responded to the item more strongly felt that these characteristics were innate as compared to learn. However, it is important to note that only 10 of the 19 senior design instructors and 26 of the 37 entrepreneurship instructors responded to this item. We do not know why the response rate for this particular item was so low; the response rates for the other sliding scale items were equal, or nearly equal, to the total number of respondents. It is possible that the instructors who left this item blank did not know how to respond. However, these results are interesting and deserve further examination. If, indeed, senior design instructors tend to believe that the necessary skills to be an entrepreneur are innate, this could impact the advice that they give students. If a design instructor feels that a student lacks what they perceive to be the inherent skills necessary to be an entrepreneur, they may push students in other directions rather than encouraging them to be an entrepreneur or to pursue the commercialization of a product that they have envisioned.

This finding is also interesting in light of the attributes and skills that entrepreneurship and design instructors categorize as being inherent to personality versus innate. Both entrepreneurship instructors and design instructors tend to feel that drive, being outgoing, passion, curiosity, and comfort with ambiguity are inherent to personality. Both also tend to feel that technical skills, communication skills, and business skills are more easily developed. There are some differences that may be open to additional exploration, particularly in beliefs surrounding comfort with taking risks, vision, ability to adapt, and ability to act on opportunities.

One area for further investigation is to compare design faculty beliefs regarding "design thinking" as being innate or learned. Given the strong parallels pointed out above between the two constructs, it may be interesting to examine whether design faculty would be more likely to believe that design thinking is a construct that can be learned. What aspects of design thinking are more readily taught versus inherent to personality? While the focus of this paper was primarily on the beliefs of faculty, in both design and entrepreneurship, future research may want to more directly compare beliefs regarding the entrepreneurial mindset and design thinking.

The similarities between the entrepreneurial mindset and design thinking are intriguing. Researchers of engineering design and entrepreneurship may be able to learn from each others' research. Studies regarding the effectiveness of instructional practices within each field may be helpful to instructors from both areas. Additionally, instructors and researchers may be interested in examining assessment instruments that have been used in each respective domain.

Acknowledgement

The authors would like to acknowledge grant support from NSF-EEC #0835992, "Entrepreneurship Education and Its Impact on Engineering Student Outcomes: The Role of Program Characteristics and Faculty Beliefs."

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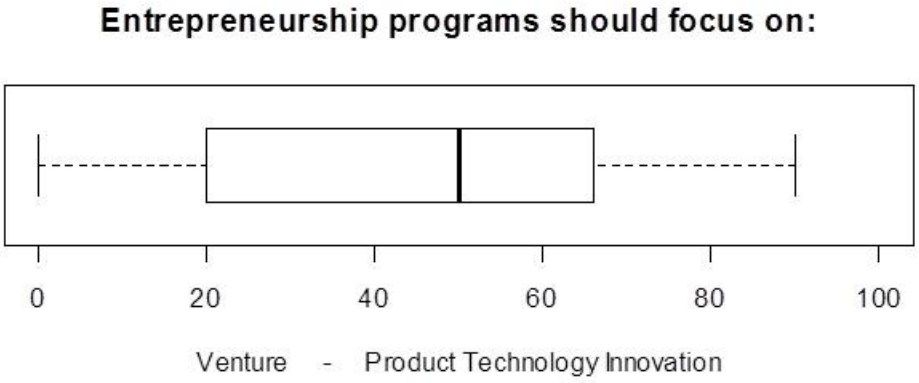
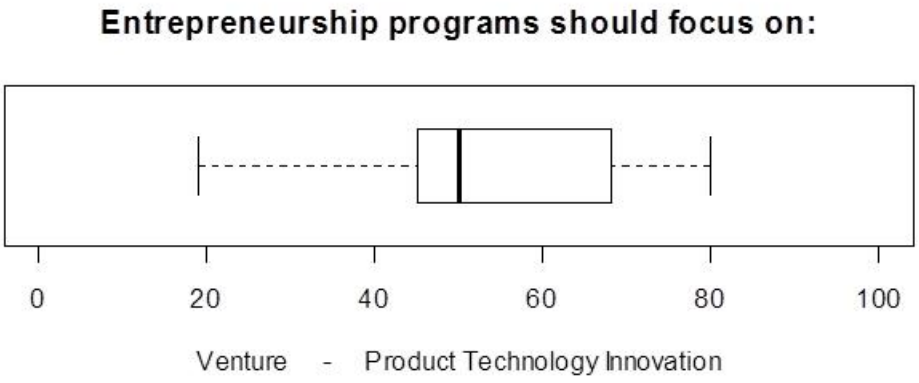
Appendix: Boxplot Figures for Sliding Scale Questions

Figure 4a: Entrepreneurship faculty's perceptions of programs (Venture vs. Product Technology)



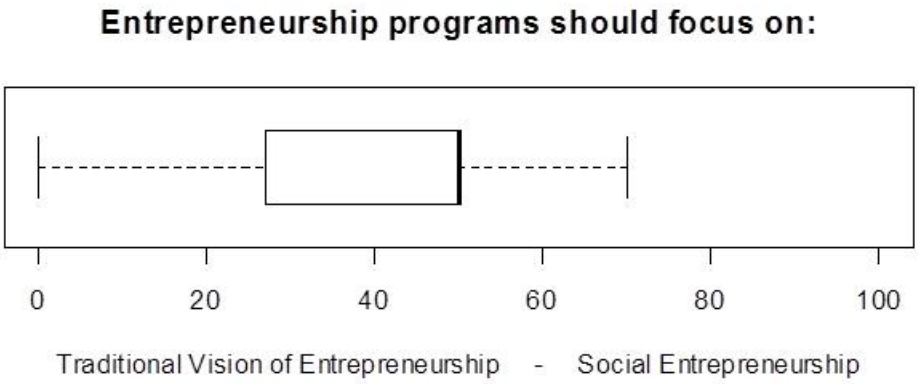
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
0	20.75	50.00	64.00	90	42.91 (N = 34)	24.27

Figure 4b: Design faculty's perceptions of programs (Venture vs. Product Technology)



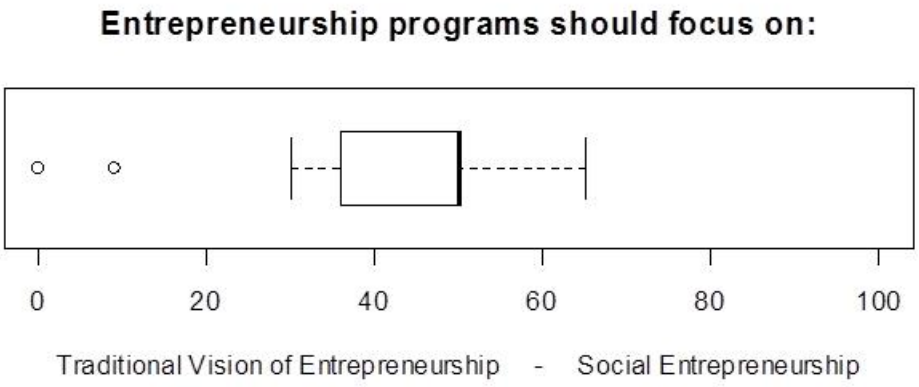
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
19	45.00	50.00	68.00	80	52.58 (N = 19)	17.01

Figure 5a: Entrepreneurship faculty's perceptions of programs (Traditional versus Social)



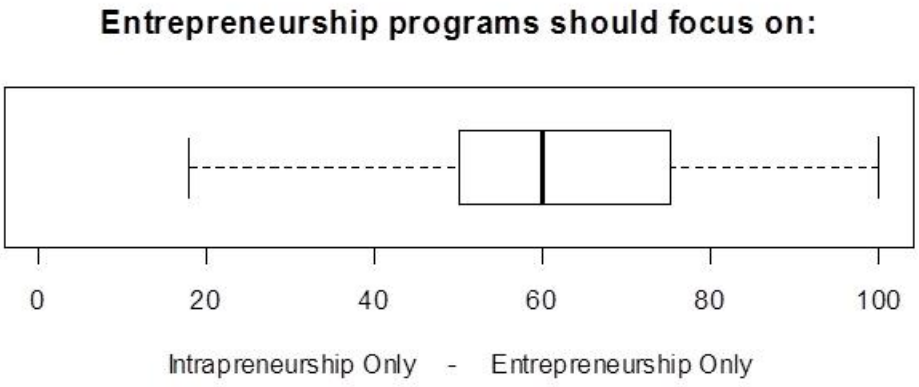
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
0	27.25	50.00	50.00	70	39.38 (N = 34)	17.88

Figure 5b: Design faculty's perceptions of programs (Traditional versus Social)



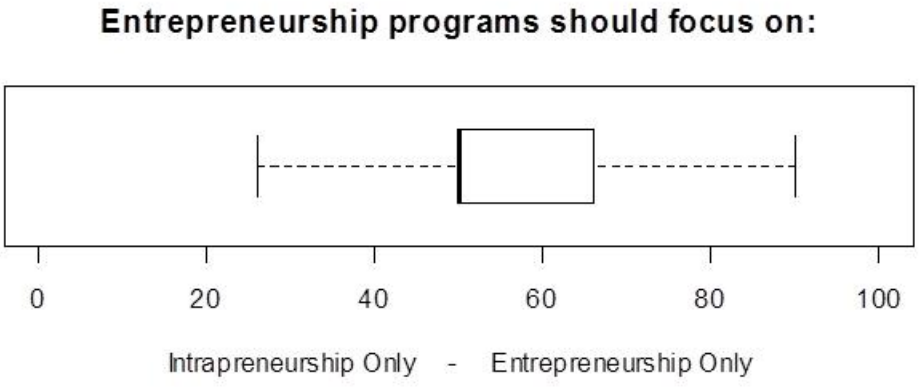
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
0	36.00	50.00	50.00	65	43.53 (N = 19)	16.97

Figure 6a: Entrepreneurship faculty's perceptions of programs (Intrapreneurship vs. Entrepreneurship)



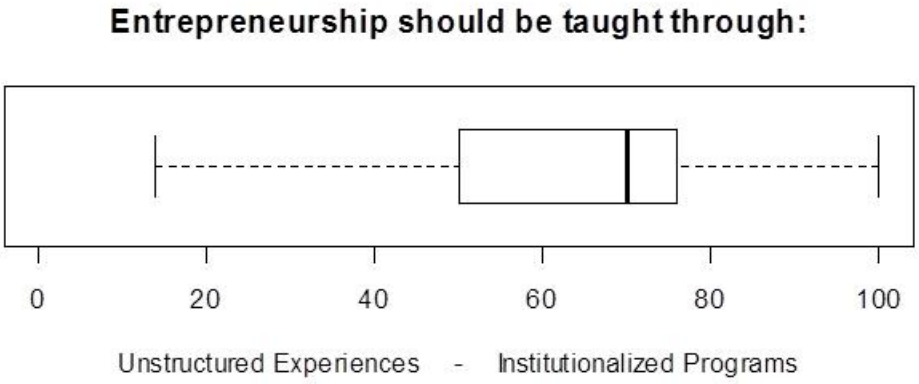
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
18	50.00	60.00	75.00	100	62.68 (N = 34)	17.60

Figure 6b: Design faculty's perceptions of programs (Intrapreneurship vs. Entrepreneurship)



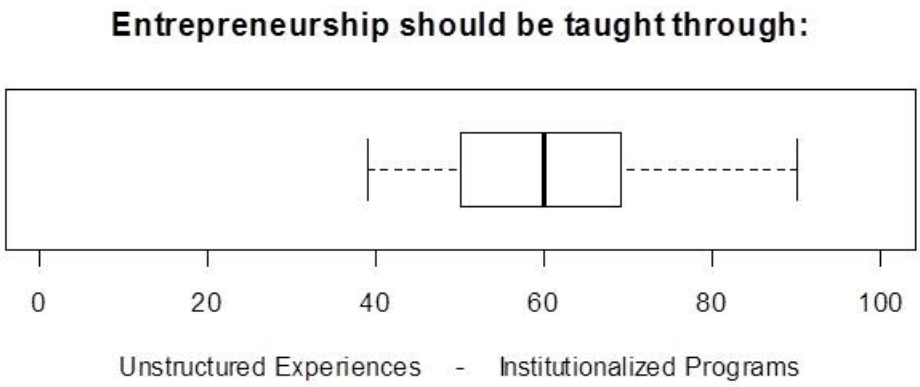
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
26	50.00	50.00	66.00	90	56.63 (N = 19)	15.41

Figure 7a: Entrepreneurship faculty's perceptions of programs (Unstructured versus Institutionalized)



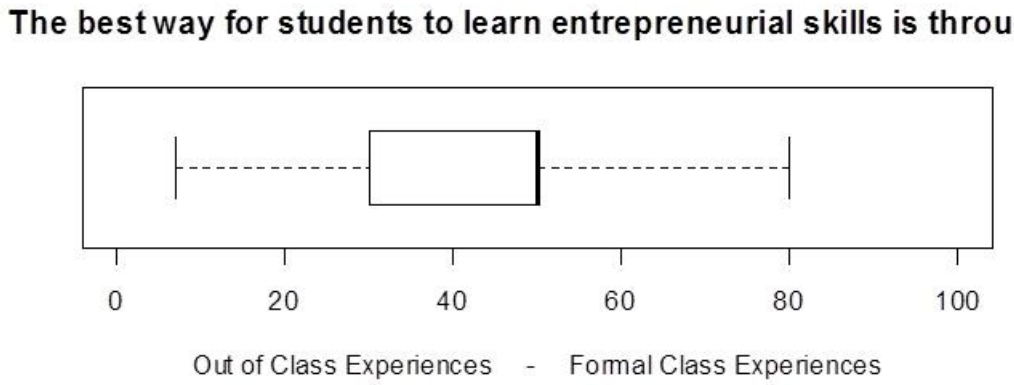
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
14	50.00	70.00	75.75	100	63.50 (N = 34)	23.66

Figure 7b: Design faculty's perceptions of programs (Unstructured versus Institutionalized)



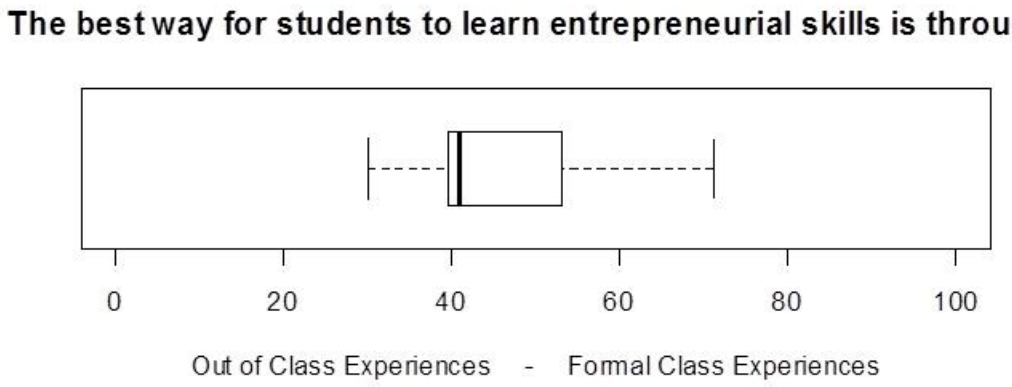
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
39	50.00	60.00	69.00	90	59.68 (N = 19)	14.63

Figure 8a: Entrepreneurship faculty's perceptions of programs (Out-of-class versus formal)



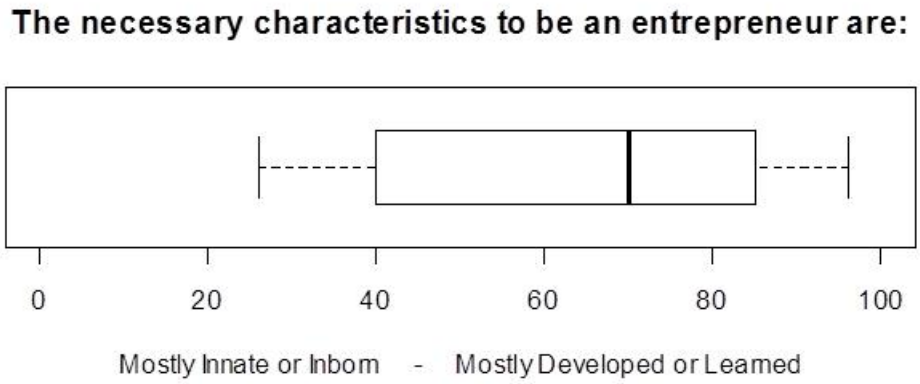
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
7	30.25	50.00	50.00	80	45.21 (N = 34)	18.56

Figure 8b: Design faculty's perceptions of programs (Out-of-class versus formal)



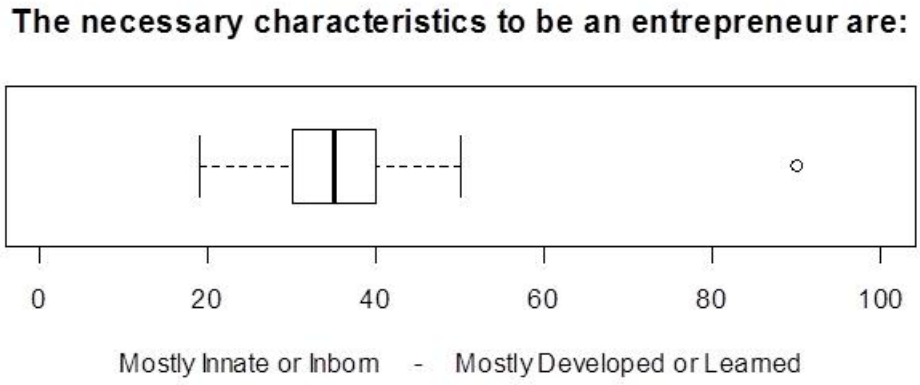
Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
30	39.50	41.00	53.00	71	46.53 (N = 19)	12.11

Figure 9a: Entrepreneurship faculty's perceptions of the nature of entrepreneurship



Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
26	40.00	70.00	84.25	96	64.35 (N = 26)	24.11

Figure 9b: Design faculty's perceptions of the nature of entrepreneurship



Minimum Value	First Quarter	Median Value	Third Quarter	Maximum Value	Average Value (Response Count)	Standard Deviation
19	30.00	35.00*	40.00	90	38.90* (N = 10)	20.31

* Indicates response percentage difference for option was ≥15% points between Entrepreneurship and Senior Design Instructors.