Comparing Engineering and Business Undergraduate Students’ Entrepreneurial Interests and Characteristics

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INTRODUCTION

Technological innovation and entrepreneurship are widely regarded as key elements to economic growth and the creation of new employment. Engineers are often important members, if not leaders, of the teams that make this innovation and entrepreneurship possible. It has become even more important for engineering graduates to not only understand business basics, but to be “flexible, resilient, creative, empathetic, and have the ability to recognize and seize opportunities”¹. To help engineering graduates succeed in this environment, engineering schools are creating courses and programs focused on innovation and entrepreneurship, sometimes drawing from business approaches in doing so ².

In designing these courses and programs, a critical first step is to understand the entrepreneurial interests and characteristics of undergraduate engineering students as compared with students majoring in business. Comparing these two groups of students suggests some of the ways that business-based courses might be modified for an engineering audience. In addition, some entrepreneurship programs are designed to service engineering and business majors; understanding how these students compare in terms of entrepreneurial interests and characteristics would allow for a better designed course for both groups of students. Nabi et al. have reported that business students showed higher entrepreneurial intent than did engineering and technology students, based on their survey of undergraduate students in England ³. Yet few other studies have systematically compared engineering and business students on their entrepreneurial interests and characteristics.

Gender also may differentiate entrepreneurial interests and characteristics of students. Previous research indicates that women are less interested in entrepreneurship and have less involvement in entrepreneurial activities than do men ⁴. Simultaneously, women tend to have lower self-assessments of their entrepreneurial ability, which may contribute to gender differences in entrepreneurship ⁵. Understanding how measures of entrepreneurial interests and characteristics vary by gender among both engineering and business majors would bring new perspectives to the design of entrepreneurial programs and courses and potentially strengthen efforts to recruit women into entrepreneurial spaces.

In light of these points, the purpose of this study is to measure and compare the entrepreneurial interests and related characteristics among engineering and business students for both genders. Our results provide important information for a wide range of people who play roles in the development of engineering students’ entrepreneurial interests. With a stronger understanding of what makes engineering students distinctive (or similar to their business major peers) in their entrepreneurial orientation various educational elements, such as pedagogies and advising strategies might be better designed to inspire their entrepreneurial interests and learning.
THEORETICAL FRAMEWORK

The theoretical framework we used to guide this research is the Relational Developmental Systems Theory (RDST), which is a popular theory in developmental science. RDST emphasizes that human development happens in the dynamic, complicated, and bidirectional relationships between individuals and their contexts (e.g., families, schools, peer groups, etc.). Individuals’ characteristics and behaviors affect their contexts; meanwhile, contexts also can influence and shape individuals. This mutually influencing mechanism takes place across a person’s entire life span. Entrepreneurship interests also can be explained as a developmental outcome in the framework of RDST.

RDST is employed in this study to inform the design of the research instrumentation and the interpretation of findings. The factors we are interested in can be categorized into two groups: “personal characteristics of individuals” and “contexts”. We hope to explain how engineering students are different from or the same as business students on these two groups of measures that are posited as being related to the development of their entrepreneurial interests.

RESEARCH QUESTIONS

Given RDST and our research objectives, the research questions guiding the present study are:

1. What are the career goals and career attributes of engineering and business undergraduate students?
2. How do engineering and business students compare on personal characteristics that might be related to entrepreneurial intent?
3. How do engineering and business students compare on contextual measures that might be related to entrepreneurial intent?
4. Do the differences between engineering and business students vary by their gender?
5. How strongly are personal and contextual measures correlated with entrepreneurial intent? Are correlations different for engineering and business students?

METHODS

The present study draws from data collected as part of the Young Entrepreneurs Study (YES). The aim of YES is to understand the development of entrepreneurship among young adults. More specifically, framed by RDST and through a mixed-methods longitudinal approach, the YES project was designed to understand which individual characteristics and which contextual measures are associated with the development of youth entrepreneurship.

YES includes three waves of data collection. This paper presents quantitative survey data from the first wave of data collection only. Prior to the first wave of data collection, a pilot study was conducted with a sample of 118 participants. Survey items were refined based on the results collected in the pilot study. The first-wave data were collected between January and June 2012. The surveys were distributed by professors in the selected universities and colleges. Students
were either given course credits or were entered into a drawing for iPads as incentives. For the purpose of this study, only undergraduate students who indicated that their field of study was engineering or business are included in the data analysis.

A. Participants

The sample for the present study is composed of 989 undergraduate student YES survey respondents. Among these participants, 518 were identified as engineering students and 471 were identified as business students. These students were from 51 different universities and colleges centered in three regions of United States: New England, the West Coast, and the Midwest. Their ages ranged between 18 and 25 years with a mean age of 21 years ($SD = 1.44$).

Table 1. Demographics of participants.

<table>
<thead>
<tr>
<th></th>
<th>Engineering</th>
<th>Business</th>
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</thead>
<tbody>
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<td>471</td>
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<tr>
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<tr>
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<td>Female</td>
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<td>1</td>
</tr>
<tr>
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<td>50</td>
</tr>
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<td>18</td>
</tr>
<tr>
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</tr>
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<td>2</td>
</tr>
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<td>356</td>
</tr>
<tr>
<td>Other</td>
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<td>5</td>
</tr>
<tr>
<td>Multiracial</td>
<td>39</td>
<td>19</td>
</tr>
<tr>
<td>Valid Total</td>
<td>517</td>
<td>470</td>
</tr>
</tbody>
</table>

Participants’ field of study was determined on the basis of their self-reported undergraduate major (an open-ended question on the YES survey instrument). Engineering majors included aero/astronautical engineering, civil engineering, chemical engineering, computer science/engineering\(^i\), electrical or electronic engineering, industrial engineering, materials engineering, mechanical engineering, and general/other engineering. Business majors included accounting, business administration, finance, international business, marketing, management, and other business.

\(^i\) Computer science students were classified as engineering majors if the departments in which they were enrolled were housed within engineering schools. They were classified as science majors (and excluded from the present sample) if the departments were housed within non-engineering schools.
The self-reported demographics of the participants are summarized in Table 1. About 42 percent and 51 percent of engineering and business participants were women\textsuperscript{ii}, respectively. There were proportionately more Asian/Asian American students among the engineering majors and proportionately more white students among the business majors. Similar proportions of students in the engineering and business majors were classified as American Indian/Alaska Native, African American, Hispanic/Latino, or Native Hawaiian/Pacific Islander (9.7 percent and 8.4 percent, respectively).

B. Measures

Drawing from the YES survey instrument\textsuperscript{8}, 31 scales/sub-scales were included in this study. The items of the 31 scales/sub-scales are summarized in Appendix. All scales/sub-scales were designed to probe relationships posited by RDST in terms of the development of youth entrepreneurship. These measures were grouped into three major categories for analysis: 1) career goals and attributes, 2) personal characteristics, and 3) contexts. The descriptions of the scales/sub-scales are summarized as follows. In our data analyses, we examined the sub-scales rather than the “parent” scales where available.

Career Goals and Attributes

Career Goal
The Career Goal measure involves a multiple-choice question asking participants to select their most important career goal. Participants were given eight options: 1) Be a musician, actor, dancer or other creative artist; 2) Be involved in politics; 3) Start a non-profit organization; 4) Start my own business; 5) Work for a non-profit organization; 6) Work within a for-profit organization/business; 7) Civil Service (e.g., education, government employee, etc.); and 8) Other. If participants selected “Other” as their most important career goal, a follow-up question asked them to “please specify”.

Entrepreneurial Intent
For this study, entrepreneurial intent is defined as a “state of mind that directs attention, experience, and action toward a business concept, set the form and direction of organizations at their inception”\textsuperscript{10}. Entrepreneurial intent is shown to be predictive of entrepreneurial behaviors in the future\textsuperscript{11-13}. The Entrepreneurial Intent scale was developed for YES through factor analysis with a number of survey items measuring participants’ life goals\textsuperscript{8}. The final scale consists of four items measuring the importance of starting/developing a new business in participants’ lives. Each item was measured on a five-point Likert scale with responses ranging from 1 (not at all important) to 5 (extremely important).

\textsuperscript{ii} On the survey instrument, participants self-reported their “sex” (female and male), which denotes biological and physical differences between the two groups. However, we refer to “gender” (women and men) in our discussion of results, as we propose that the characteristics measured in this study are more related to the social roles of the two groups Scutt, H. I., Gilmartin, S. K., Sheppard, S. & Brunhaver, S. in ASEE Annual Conference & Exposition.
Career Values
Career values are defined as the importance attached to various rewards of careers. Career values are closely related to career choice. The scale of Career Values was adapted from the Job Value Scales. Three career value sub-scales were constructed for YES: Middle Management (5 items), Challenging (6 items), and Social (2 items). An example item from the sub-scale of Middle Management is “A career that offers a reasonably predictable, secure future.” An example from the sub-scale of Challenging is “A career where you can see the payoff of what you create.” An example from the sub-scale of Social is “A career that is worthwhile to society.” Items in each scale were measured on a five-point Likert scale with responses ranging from 1 (not important) to 5 (extremely important).

Personal Characteristics

Innovation Orientation
The scale of Innovation Orientation was adapted from Scott and Bruce’s measures of individuals’ innovative behavior. The scale includes six items that ask participants to rate the extent to which they engage in a list of behaviors. Example items are “Search out new technologies, processes, techniques, and/or product ideas” and “Develop adequate plans and schedules for the implementation of new ideas.” The items were measured on a five-point Likert scale with responses ranging from 1 (almost never) to 5 (almost always).

Intentional Self-Regulation
The sub-scales Goal Selection, Goal Optimization, Goal Compensation, and Loss-Based Goal Selection were selected from the Entrepreneurial Intentional Self-Regulation Questionnaire (EISR). The EISR was developed for YES to measure self-regulation skills related to entrepreneurial behavior. In EISR, participants were asked to rate the way they approach and accomplish goals in their lives. The items in EISR were measured on a five-point Likert scale with responses ranging from 1 (almost never) to 5 (almost always).

Goal Selection includes two sub-scales: Novel (3 items) and Challenge (3 items). Selection of novel goals represents a preference for selecting goals others have not considered or that fulfill an unmet need. An example item from Goal Selection-Novel is “I like to pursue projects that others have not thought about pursuing.” Selection of challenging goals represents a preference for selecting challenging goals, projects, and tasks. An example item from Goal Selection-Challenge is “I prefer to take on challenging projects.”

Goal Optimization includes two sub-scales: Self-Starter (3 items) and Persistence (3 items). Goal Optimization-Self Starter represents the ability to self-motivate goal optimization. An example item from the sub-scale of Self Starter is “I take initiative when something needs to get done.” Optimization through persistence represents diligence and efficiency in goal attainment. An example item from the sub-scale of Persistence is “I work diligently to complete my tasks.”
Goal Compensation (6 items) represents the ability to switch gears and apply alternative means for reaching a goal when faced with setbacks or failures. An example item from the scale of Goal Compensation is “When one approach fails, I try different ways to reach my goals.”

Loss-Based Goal Selection (4 items) represents the ability to adaptively switch goals in the face of insurmountable failure. An example item is “I keep an eye out for other opportunities I can pursue in case a project fails.”

TENFLEX
The scale labeled TENFLEX was adapted from the Tenacious Goal Pursuit scale and the Flexible Goal Adjustment scale. TENFLEX measures participants’ pursuit of goals under difficult circumstances and adjustment to difficulties in attaining goals. TENFLEX includes two sub-scales: Tenacious Goal Pursuit (7 items) and Flexible Goal Adjustment (3 items). An example item from the sub-scale of Tenacious Goal Pursuit is “The harder a goal is to achieve, the more appeal it has to me”, and an example from the sub-scale of Flexible Goal Adjustment is “I adapt quite easily to changes in plans or circumstances.” The items were measured on a five-point Likert scale with responses ranging from 1 (almost never) to 5 (almost always).

Self-Efficacy Optimism
Self-efficacy has been shown in previous studies to be important to entrepreneurial intent. The scale of Self-Efficacy Optimism includes six items that were selected from the Questionnaire for the Assessment of Personal Optimism and Social Optimism–Extended (POSO-E). Self-Efficacy Optimism measures the belief that “future outcomes can be influenced in a positive way.” An example item is “I master difficult problems.” The items were measured on a five-point Likert scale with responses ranging from 1 (almost never) to 5 (almost always).

Machiavellian
We included a Machiavellian scale, since a Machiavellian personality is posited to be related to successful entrepreneurship or management. A Machiavellian personality is conceptualized as “one’s propensity to distrust others, engage in amoral manipulation, seek control over others, and seek status for oneself.” The scale was adapted from the Machiavellian Personality Scale (MPS) with three sub-scales: Morality (5 items), Control (3 items), and Status (3 items). Participants were asked to rate how much they agree or disagree with 11 statements, e.g., “I am willing to be unethical if I believe it will help me succeed”, each measured on a five-point Likert scale from 1 (disagree) to 5 (agree).

Assertiveness
Assertiveness was included in this study as it is regarded as a characteristic of successful entrepreneurs. The Assertiveness scale includes three items that were adapted from Little. An example item is “When I talk with others, I give my real opinions and thoughts.” The items were measured on a five-point Likert scale with responses ranging from 1 (disagree) to 5 (agree).

Hopeful Future Expectations
Hopeful Future Expectations may be related to positive youth development. The scale of Hopeful Future Expectations measures participants’ expectations that they will experience
certain situations later in life. Participants were asked the following question in the survey: “Think about how you see your future. What are your chances for the following?” There are two sub-scales: Life (5 items) and Money (5 items). An example item from the sub-scale of Life is “Have a job you like doing” and an example item from the sub-scale of Money is “Be able to buy the things you want.” The items were measured on a five-point Likert scale with responses ranging from 1 (Very Low) to 5 (Very High).

Sense of Self
The scale of Sense of Self was adapted from the Stanford Youth Purpose Survey. This scale measures characteristics that are relevant to participants’ sense of who they are as a person. Participants were asked to respond according to the centrality of these qualities to their identity, rather than how desirable they think these characteristics are in general. Two sub-scales were included: Movers & Shakers (9 items) and Conventional (4 items). An example item from the sub-scale of Movers & Shakers is “Willing to stand up for what I believe is right” and an example item from the sub-scale of Conventional is “Responsible, someone others can depend on.” The items were measured on a five-point Likert scale with responses ranging from 1 (Not at all Central to my Sense of Self) to 5 (Very Central to my Sense of Self).

Personal Values
The scale of Personal Values includes five items selected from the Search Institute’s Profiles of Student Life-Attitudes and Behaviors (PSL-AB) Questionnaire. The scale measures the importance a participant places on personal values, such as standing up for what one believes in and telling the truth. An example item is “Doing what I believe is right, even if my friends make fun of me.” The items were measured on a five-point Likert scale with responses ranging from 1 (Not Important) to 5 (Extremely Important).

Positive Youth Development (PYD)
This scale measures positive youth developmental outcomes. There are two sub-scales in this scale: Confidence (3 items) and Caring (3 items). An example item from the sub-scale of Confidence is “All in all, I am glad I am me” and an example item from the sub-scale of Caring is “When I see someone being taken advantage of, I want to help them.” The items were measured on a five-point Likert scale with responses ranging from 1 (disagree) to 5 (agree).

Contexts
Mentoring
The scale of Mentoring (4 items) measures the presence of adult mentors in participants’ lives. In each item, participants were asked to indicate the number of non-parental adults they had known for one or more years who met a series of criteria that define an adult mentor. An example item from the scale of Mentoring is “Give you lots of encouragement whenever they see you.” The responses ranged from 0 (zero) to 4 (four or more).

Family/Friends
The scale of Family/Friends was used to assess the role of family and friends. Two sub-scales were employed for analysis: Family (5 items) and Friends (4 items). An example item is “My
family encourages me to develop my interests”. The items were measured on a five-point Likert scale with responses ranging from 1 (strongly disagree) to 5 (strongly agree).

Entrepreneurship Activities
The Entrepreneurship Activities scale measures the number of times participants had been involved in seven different entrepreneurial activities: 1) starting a club, 2) organizing people around a cause, 3) devising ways to make money, 4) designing a new product or service, 5) developing a business plan, 6) starting a business, and 7) buying or selling a company. The five response options ranged from “0” to “4 or more”.

Extra-Curricular Activities
The Extra-Curricular Activities scale measures whether participants had been involved in four types of activities: 1) 4-H Clubs, 2) Young Professional Organizations, 3) Entrepreneurship Clubs, and 4) Boy/Girl Scouts. The response choices for each activity were 1 (yes) or 0 (no).

C. Score Calculation and Reliability

For all scales/sub-scales except Extra-Curricular Activities, scores were calculated by averaging the item scores. For Extra-Curricular Activities, a sum of the four items was calculated to represent the extent to which the students participated in these activities.

The reliability of the scales was measured through Cronbach’s coefficient alphas. Table 2 summarizes the number of items and Cronbach’s alphas for each of the scales/sub-scales. Except for two sub-scales in Career Values (Middle Management and Social), all scales/sub-scales had Cronbach’s alphas greater than 0.7, which is considered acceptable reliability in social science. Middle Management and Social were retained in the data analysis, since the alphas were only slightly lower than the cut-off of 0.7.
Table 2. Number of items and Cronbach’s alphas of the scales/sub-scales measured in the YES survey instrument.

<table>
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<tr>
<th>Scales and Sub-scales</th>
<th># of Items</th>
<th>Cronbach’s alpha</th>
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<tr>
<td>Career Values</td>
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<tr>
<td>Middle Management</td>
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<td>Challenge</td>
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<td>Morality</td>
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<td>Friends</td>
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D. Data Analysis

In this study, we are interested in comparing different groups of students on their entrepreneurial interests and related factors. All statistical analyses were conducted using IBM SPSS Statistics 21.

To compare means of Likert-scale measures, we performed independent sample t-tests and report p-values as well as Cohen’s d as an indicator of effect size. Cohen’s d calculations help to compensate for the dependence of p-values on sample size. That is, when the sample size is very large, nearly all differences, even meaningless differences, can have very small p-values (e.g., <.05). By contrast, the effect size, Cohen’s d, is a measure of the greatness of difference and is independent from sample size. Thus, both Cohen’s d and p-value were calculated in each of the comparisons to better interpret differences between groups. For the purpose of reporting, we focus on differences having a minimum effect size of “small” using Cohen’s rubric 32.

For categorical measures in our study (e.g., Career Goal), we tested group differences using chi-square tests. A chi-square test is a commonly used non-parametric test that can be used to test differences on categorical scales.

Pearson correlation coefficients were calculated to look at simple linear correlations between the non-categorical measures.
RESULTS

In this section, our findings are organized based on our research questions (1), (2), (3), and (5). We include the results of our gender comparisons (research question (4)) in each sub-section to provide a more comprehensive picture of how major and gender might differentiate the entrepreneurship-related measures under study.

1. What Are the Career Goals and Career Attributes of Engineering and Business Undergraduate Students?

1A) Career Goals

Figure 1 summarizes engineering and business students’ responses to the career goal question on the YES instrument. The eight career goal categories were aggregated into three larger categories for the purpose of analysis: 1) be a musician, actor, dancer, or other creative artist, or be involved in politics, 2) start a non-profit organization or start a business, and 3) work within a non-profit organization or work within a for-profit organization, or civil service.

Engineering and business students’ responses to these categories were significantly different according to a Chi-square test ($\chi^2(7) = 71.96, p < .001$). Engineering students were more interested in working within existing organizations than were business students (51.0% for engineering students vs. 43.1% for business students), while business students were more interested in starting their own organization (non-profit or business) (43.7% for business students vs. 25.1% for engineering students). Only small percentages of engineering and business students wanted to be in a creative-artist position or involved in politics.

Engineering students more often selected "other" for their career goal. Among the engineering students who selected “other” for their career goal and provided explanation ($n = 115$), 20.0 percent emphasized the social meaning of their careers (e.g., to help others or to contribute to the society); 14.8 percent emphasized intrinsic interests towards jobs (e.g., careers that they can enjoy); 9.6 percent specified the fields they wanted to work on but did not express which kind of organization they wanted to work in; 9.6 percent wanted to be “engineers” but did not express which kind of organization they wanted to work in; 7.0 percent wanted to have academic or research jobs; and the balance provided answers that could not be categorized into one of the above groups (i.e., vague answers).

Among the business students who selected “other” for their career goal and provided explanation ($n = 40$), 30.0 percent specified the positions/fields they wanted to work on but did not express which kind of organization they wanted to work in; 15.0 percent emphasized intrinsic interests towards jobs (e.g., careers that they can enjoy); 10.0 percent emphasized having impacts on a business/company; 7.5 percent emphasized the social meaning of their careers (e.g., to help others or to contribute to the society); and only 2.5 percent (one person) wanted to have an academic or research job. The balance provided answers that could not be categorized into the above groups.
When we take gender into consideration, engineering men had higher rates of interest in starting a non-profit organization or starting their own business (32.1%) than did engineering women (15.1%). The difference between the two groups was significant ($\chi^2 (7) = 22.51, p = .002$). Similar trends were observed for business men and women ($\chi^2 (7) = 50.49, p < .001$). Furthermore, engineering women’s career goal responses were significantly different from those of business women ($\chi^2 (6) = 50.12, p < .001$), and engineering men’s career goal responses were significantly different from those of business men ($\chi^2 (7) = 42.31, p < .001$).

Examining each of the eight goal categories in a separate set of analyses, relatively small percentages of students wanted to start or work for a non-profit organization. Business women reported higher rates of interest in starting a non-profit organization (4.3%) or working for a non-profit organization (13.0%) than did the other three groups (2.1% and 1.3% of business men, 1.6% and 4.9% of engineering women, and 1.9% and 4.1% of engineering men wanted to start a non-profit organization or work for a non-profit organization, respectively). The percentages of students who wanted to start or work for non-profit organizations were similar for engineering men and women.

![Figure 1](image.png)

**Figure 1.** Career goals of engineering and business undergraduate students by gender.

### 1B) Entrepreneurial Intent

The entrepreneurial intent of engineering and business students was measured using a four-item scale. The means and standard deviations on this scale are summarized in Table 3, along with four sets of comparisons. More specifically, Table 3 compares:
- all business and engineering students are compared (I),
- all males and females (II),
- engineering males and females (III), and finally,
- business males and females (IV).
From this we see that business students showed higher entrepreneurial intent compared with engineering students. This mean difference is classified as “medium” using the rubric defined by Cohen. Moreover, men showed higher entrepreneurial intent than did women among both engineering and business majors. Business men had the highest mean score among all four groups (four-way differences were not statistically tested).

1C) Career Values

Three different career values were measured in this study: Middle Management, Challenging, and Social.

For the sub-scale of Middle Management, business students showed higher interest in rewards associated with middle management (e.g., good earnings potential and a manageable schedule) than did engineering students. This difference is classified as “small” based on Cohen’s rubric. A gender difference was not found on this sub-scale among either the engineering or business majors.

For the sub-scale of Challenging, engineering and business students valued challenging careers (e.g., autonomous, creative, difficult, and with visible payoff) at similar levels. Engineering men showed more interest in a challenging career than did engineering women, but this gender difference was not observed among business students. Further, engineering men were not different from business men; however, a difference was observed between engineering women and business women. Engineering women had the lowest score on this sub-scale among all four groups.

Overall, engineering and business students valued careers that are beneficial to society at similar levels. Women valued the social meanings of their career more strongly than did men, with a marginal difference (Cohen’s d = 0.19). Business women valued the socially meaningful dimensions of work more strongly than did business men, which appears to be consistent with the finding reported above that business women showed more interest in starting or working in non-profit organizations. Engineering women also had a higher mean score than did engineering men in the sub-scale of Social, although the difference was minimal.

2. How Do Engineering and Business Students Compare on Personal Characteristics That Might Be Related to Entrepreneurial Intent?

Table 4 summarizes the means and standard deviations of personal characteristic measures that might be related to entrepreneurial intent for engineering and business students. Engineering and business students were found to be similar in the following measures: Goal Selection (Novel and Challenge), Goal Optimization-Persistence, Goal Compensation, Loss Based Selection, TENFLEX (Tenacious Goal Pursuit and Flexible Goal Adjustment), Machiavellian-Morality, and Assertiveness. However, business students had higher mean scores than engineering students on the following measures: Innovation Orientation, Goal Optimization-Self Starter, Machiavellian (Control and Status), Self-Efficacy Optimism, Future Orientation, Hopeful Future Expectations (Life and Money), Sense of Self (Movers & Shakers and Conventional), Personal Values, and Positive Youth Development (Confidence and Caring).
Men had higher mean scores than women on Innovation Orientation, Goal Selection (Novel and Challenge), TENFLEX-Flexible Goal Adjustment, Self-Efficacy Optimism, and Machiavellian (Morality, Control and Status). Women had higher mean scores on Future Orientation and Positive Youth Development (PYD)-Caring than did men.

With both gender and major considered, engineering women showed the lowest scores among the four groups on several measures (again, four-way differences were not statistically tested): Innovation Orientation, TENFLEX (Tenacious Goal Pursuit and Flexible Goal Adjustment), Self-Efficacy Optimism, Machiavellian (Control and Status), and Hopeful Future Expectations-Money. The highest average scores on Assertiveness and PYD-Confidence were observed among business men, while the highest average score for PYD-Caring was observed among business women.

For Innovation Orientation, we examined students’ scores at item level (data not listed). Engineering students were slightly more likely than business students to “search out new technologies, process techniques, and/or product ideas” (although the p-value was greater than .05; Cohen’s d = 0.08), while business students showed higher scores on three items: 1) “promote and champion ideas to others” (p < 0.001; Cohen’s d = 0.26), 2) “investigate and secure funds needed to implement new ideas” (p < 0.001; Cohen’s d = 0.34), and 3) “develop adequate plans and schedules for the implementations” (p < 0.001; Cohen’s d = 0.23). Business students also showed slightly higher scores on two items measuring general innovation orientation: 1) “Generate creative ideas” (p = 0.100; Cohen’s d = 0.11), and 2) “Are innovative” (p = 0.762; Cohen’s d = 0.02).

3. How Do Engineering and Business Students Compare on Contextual Measures That Might Be Related to Entrepreneurial Intent?

We also compared engineering and business students on a series of contextual measures. The means and standard deviations of these measures are summarized in Table 5. Business students had higher average scores on Mentoring, Entrepreneurship Activities, and Extra-Curricular Activities than engineering students. Men reported more entrepreneurship activity than did women among both engineering and business majors. Larger differences in Entrepreneurship Activities were observed among business women and men as compared to among engineering women and men.

Compared with engineering men, engineering women reported more supports from their friends while a gender difference in Friends was not observed among business students. Instead, business men were more likely than engineering students to report having people in their lives meeting the qualities of a “mentor.”
Table 3. Means and standard deviations of Entrepreneurial Intent, Innovation Orientation, and Career Values.

<table>
<thead>
<tr>
<th>Scale</th>
<th>All (Engineering and Business)</th>
<th>Engineering (II)</th>
<th>Business (IV)</th>
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<tbody>
<tr>
<td></td>
<td>Male</td>
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<tr>
<td>Challenging</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Social</td>
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</table>

| Table 4. Means and standard deviations of individual characteristics that might be related to entrepreneurial intent.

<table>
<thead>
<tr>
<th>Scale</th>
<th>All (Engineering and Business)</th>
<th>Engineering (II)</th>
<th>Business (IV)</th>
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<td>p-value</td>
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</table>

Cohens guidelines: small d = 0.2, medium d = 0.5, large d = 0.8. *Cohen's d's that were larger than 0.2 were highlighted in bold.

Two-tailed p-values from t-tests.
Table 5. Means and standard deviations of contextual factors.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Between-Major Comparison (I)</th>
<th>All (Engineering and Business) (II)</th>
<th>Engineering (III)</th>
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<tr>
<td>Extra-Curricular Activities</td>
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<td>.27</td>
<td>.06</td>
<td>.31</td>
</tr>
</tbody>
</table>

Cohen's d Guidelines: small d = 0.2 - 0.5, medium d = 0.5 - 0.8, and large d ≥ 0.8. Cohen's ds larger than 0.2 were highlighted in bold.

*Two-tailed p-values from t-tests.
4. How Strongly Are the Measures Correlated with Entrepreneurial Intent? Are Correlations Different for Engineering and Business Students?

Simple correlations between Entrepreneurial Intent and all other measures under study except the categorical Career Goal measure are summarized in Table 6. These correlation coefficients indicate how strongly personal characteristics and contextual measures are associated with entrepreneurial intent among engineering and business students. Simple correlation coefficients also provide preliminary insights into which measures may be most predictive of entrepreneurial intent and thus could be included in a multivariate model with Entrepreneurial Intent as a dependent variable.

All measures were positively correlated with Entrepreneurial Intent, except Positive Youth Development (PYD)-Caring ($r = -0.01, p > .05$) for engineering students and Family ($r = -0.04, p > .05$) for business students. The measures that were moderately correlated ($r$ between 0.3 and 0.5) with Entrepreneurial Intent for both engineering and business students include: Career Values-Challenging, Innovation Orientation, Goal Selection (Novel and Challenge), and Sense of Self-Movers & Shakers.

Generally speaking, the correlation coefficients shown in Table 6 were similar for engineering and business students. Only small differences exist. For example, stronger correlations were observed between Entrepreneurial Intent and the three Machiavellian measures (Morality, Control and Status) among engineering students than among business students. The correlation coefficient between Entrepreneurial Intent and Entrepreneurship Activities is larger for engineering students than for business students. On the other hand, the following measures had stronger correlations with Entrepreneurial Intent for business students than for engineering students: Career Values-Challenging, Goal Selection-Novel, and Sense of Self- Movers & Shakers.
Table 6. Pearson correlation coefficients of the measures with Entrepreneurial Intent among engineering and business students.

<table>
<thead>
<tr>
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<td>Entrepreneurship Activities</td>
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</tr>
<tr>
<td>Extra-Curricular Activities</td>
<td>.12**</td>
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</tbody>
</table>

* p < .05  ** p < .01  *** p < .001

Correlation coefficients that are larger than 0.3 are highlighted in bold.
DISCUSSION

In this study we compared engineering and business undergraduate students on measures of entrepreneurial interests and career goals, as well as on personal characteristics and contexts that may be related to entrepreneurship within a Relational Developmental Systems Theory framework. Few previous studies have compared students from different disciplines on these measures. Our results thus provide an important reference for those inter- and multi-disciplinary entrepreneurship programs and courses designed for engineering students and their peers in other fields.

Our findings indicate that more business students have more interest in starting their own organization and have higher entrepreneurial intent than do engineering students. This finding is consistent with findings from Nabi et al.’s study of undergraduate students in England. Our study also took gender into account. Men were more likely than women to cite starting their own organization as their career goal, and had higher entrepreneurial intent than did women. This gender gap was found among both business and engineering students and is consistent with previous research. With both discipline and gender considered, business men were most interested in starting their own organization and had the highest entrepreneurial intent, followed by business women and engineering men. Engineering women had the lowest levels of entrepreneurial intent.

However, by analyzing students’ interests in starting different types of organizations, we note a caveat to gender differences in entrepreneurial interests. Although the rate of interest in starting a non-profit organization is small for all groups under study (< 5%), business women showed stronger interests in starting a non-profit organization than did business men. Moreover, although engineering women showed lower entrepreneurial intent than did engineering men, the two groups reported similar levels of interests in starting a non-profit organization. These findings may be linked with results of the measure labeled Career Value-Social: women valued the social meanings of their career more strongly than did men, although only marginal difference was observed (Cohen’s d = 0.19). This gender difference was present among students in both disciplines, keeping in mind that the gender difference in business was larger than the gender difference in engineering. Generally, these findings are in line with Johnson’s finding on gender differences in career values.

Our analyses of personal characteristic measures suggest that although engineering and business students are similar on many developmental traits that may have traction in helping to explain entrepreneurial behaviors, small differences favoring business students are observed on some of these traits, such as innovation orientation, the way they optimize their goals, seeking status, and seeking control over others. These findings have not been reported by previous studies. Meanwhile, small differences favoring men are observed on traits such as innovation orientation, the way they select their goals, self-efficacy optimism, and Machiavellianism, while differences favoring women are observed on measures of future orientation and “caring”. These differences hold for both business and engineering students. Similar gender differences have been reported elsewhere on self-efficacy and Machiavellianism.
For the contextual measures, the results suggest that business students may have more interactions with mentors and have been more involved in entrepreneurship activities and extra-curricular activities. Importantly, men are more frequently involved in entrepreneurship activities than are women in this sample.

Our correlation analyses confirmed that many of the individual characteristics and contextual measures under study are positively associated with entrepreneurial intent, as would be posited by RDST. Specifically, for both engineering and business students, Career Values-Challenging, Innovation Orientation, Goal Selection (Novel and Challenge), and Sense of Self-Movers & Shakers are moderately correlated with Entrepreneurial Intent. To some extent, these scales all measured whether students value creativity/innovativeness in their careers or saw themselves as creative/innovative. Thus, the positive correlations are intuitively understandable, since creativity and innovation are commonly regarded as highly associated with entrepreneurship. However, business students tend to have higher mean scores than do engineering students on several of these measures that are most closely associated with entrepreneurial intent (e.g., innovation orientation); men, moreover, are more likely than women to value careers that offer them creative autonomy, and see themselves to be innovation oriented, and to select novel and challenging goals. Thus, some students (business majors and men) seem to be more proximate to entrepreneurship than do others (engineering majors and women) in terms of related personal attributes in this study.

In light of RDST, what was surprising to us was the relatively weak correlations between Entrepreneurship Intent and the contextual measures, e.g., Mentoring, Family, Friends, and Extra-Curricular Activities. Entrepreneurship Activities was not highly correlated with Entrepreneurial Intent either. These results do not suggest that contexts on the whole are unrelated to the development of students’ entrepreneurial interests. Instead, they raise at least two questions: are there other, more granular contexts to measure that could help to explain field and gender differences in personal attributes related to entrepreneurship? And which of these contexts are most effective in supporting engineering students’ entrepreneurial interests?

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

**Implications for Research**

In this study, small differences were found between business and engineering students on several personal characteristic measures that may be related to entrepreneurial intent. This suggests that field is a key covariate in models of entrepreneurial development. However, it is not clear if these differences existed prior to students selecting their majors, or represent the effects of discipline-specific environments. More work is needed to disentangle self-selection from environmental effects in terms of the development of certain traits that make one more or less likely to pursue entrepreneurial career paths (not to mention interest in these paths to begin with). Future research could compare engineering and business students prior to college matriculation and/or major declaration as well as after graduation to test how college contexts such as major may influence students.
Along these lines, only a select number of contextual factors (supports from family and friends, contacts with mentors, and previous entrepreneurial and extra-curricular activities) were examined in this study. These factors showed relatively low correlations with students’ entrepreneurial intent. Future studies ought to look into additional contextual factors and investigate how these factors may not only correlate with students’ entrepreneurial intent but also help to explain field and gender differences in personal attributes that might be considered “entrepreneurial assets” (e.g., valuing autonomy and creativity in careers, selecting novel goals). For example, these factors may include specific types of educational contexts (e.g., participation in entrepreneurship courses and enrollment in certificates and minors), cultural contexts (e.g., attitudes and behaviors of peers), and other social-psychological contexts (e.g., the salience of gender schemas and stereotypes). These studies would ideally collect longitudinal data to assess changes in students’ entrepreneurial interests and thereby help to make inferences about how educational contextual factors, might influence students’ entrepreneurial interests. Future studies could also test interactions between discipline and gender to elaborate on the findings in this study (where four-way differences were not statistically tested).

Both interest and knowledge can affect students’ career choice decision making. To choose an entrepreneurial career, an individual should be both interested in and have enough knowledge about entrepreneurship. The current work mainly examines students’ interests, and their developmental correlates. Future studies might include additional measures of students’ knowledge of business- and entrepreneurship-related principles to build a more comprehensive picture of students’ career choice decision making.

Finally, for the YES project, innovation orientation was measured in a somewhat general way. For example, participants were asked how likely it was that they would generate creative ideas and develop plans to implement their ideas. Only one out of the six items asked students about the likelihood of “searching out new technologies, processes, techniques, and/or product ideas”. We propose that a modified innovation orientation scale might be created specifically for engineering and technology students to measure their technology-based innovation orientation. We hypothesize that engineering students would respond differently to this new scale.

**Implications for Practice**

Our results hint that women may have greater preference for starting a non-profit organization and may value the social meanings of their career more strongly than do men. Recall that engineering women also have the least interest in entrepreneurship. Based on these results, we suggest that entrepreneurial programs and courses could consider including more content on non-profit business models and social entrepreneurship as part of attracting and sustaining a broader spectrum of students.

More generally, our findings raise many questions for courses and programs that either adapt business models to engineering classrooms or bring engineering and business students of both genders together. For instance, are traditional measures of entrepreneurial intent appropriate for all students, or to what extent can programs broaden their definition of entrepreneurial interest? To what extent should programs be designed for engineers specifically (i.e., designed to fit closely with the highly technical training of engineers)? How can we create better
entrepreneurial contexts for engineering students? Which contexts may be more effective in inspiring engineering students’ interests towards entrepreneurship and innovativeness?

SUMMARY

This study provides a comprehensive description of engineering students’ entrepreneurial interests and characteristics, as compared with their peers in business majors. Gender differences were also measured among engineering and business students.

The results indicated that:
1. Engineering students have lower entrepreneurial intent than do business students;
2. Business students evaluate themselves more positively than engineering students on characteristics that are related to entrepreneurship, such as innovation orientation, the way they optimize their goals, seeking status, and seeking control over others;
3. Business students have more interactions with mentors and have been more involved in entrepreneurship activities and extra-curricular activities;
4. Women have lower entrepreneurial intent than do men across both disciplines;
5. Women evaluate themselves less positively than men on traits such as innovation orientation, the way they select their goals, self-efficacy optimism, and Machiavellianism for both engineering and business students;
6. Men are more frequently involved in entrepreneurship activities than are women for both disciplines;
7. However, women are more future oriented and rate themselves more positively on the measure of “caring” than do men, and women are more interested in starting a non-profit organization and engaging in careers with social rewards than are men for both disciplines;
8. The following measures are moderately correlated with students’ entrepreneurial intent for both disciplines: Career Values-Challenging, Innovation Orientation, Goal Selection (Novel and Challenge), and Sense of Self-Movers & Shakers.

Within a theoretical framework of RDST, we explained that the differences in entrepreneurial intent are related to differences in the personal characteristics and contexts. The results of this study provide important references for engineering educators who play important roles in the development of engineering students’ entrepreneurial interests.

ACKNOWLEDGMENTS

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REFERENCES


Bundick, M. *et al.* Revised Youth Purpose Survey (Stanford Center on Adolescence, Stanford, CA, 2006).


APPENDIX

---------------------------------------------Career Attributes---------------------------------------------

Entreprenurial Intent
Participants are asked to rate how important the following goals are in their lives. Responses range from 1 = not at all important, through 5 = extremely important.
1) Start my own business
2) Develop my own business
3) Start a new organization
4) Change the way a business or organization runs

Career Values
Participants are asked to rate how important the following are to them in their careers. Responses range from 1 = not important to 5 = extremely important.

Middle Management
1) A career that provides you with a chance to earn a good deal of money.
2) A career that offers a reasonably predictable, secure future.
3) A career that leaves a lot of time for other things in your life.
4) A career where you don't need to work more than 40 hours per week.
5) A career where the everyday work routines are clearly laid out for you.

Challenging
1) A career where you make decisions.
2) A career where most problems are quite difficult and challenging.
3) A career that is interesting to do.
4) A career where you can see the payoff of what you create.
5) A career where you can have the chance to be creative.
6) A career that leaves you mostly free of supervision by others.

Social
1) A career that gives you an opportunity to be directly helpful to others.
2) A career that is worthwhile to society.

-----------------------------------------------Personal Characteristics----------------------------------------------

Innovation Orientation
Participants are asked to rate the extent to which they partake in a list of behaviors. Responses range from 1 = almost never to 5 = almost always.
1) Search out new technologies, processes, techniques, and/or product ideas
2) Generate creative ideas
3) Promote and champion ideas to others
4) Investigate and secure funds needed to implement new ideas
5) Develop adequate plans and schedules for the implementation of new ideas
6) Are innovative

Goal Selection
Participants are asked to select choices that describe the ways they approach and accomplish goals in their lives. Responses range from 1 = almost never, through 5 = almost always.

Goal Selection-Novel
1) I like to pursue projects that others have not thought about pursuing.
2) I am interested in projects that involve new ideas.
3) I take on ventures that address unmet needs.

Goal Selection - Challenge
1) I select challenging goals.
2) I prefer to take on challenging projects.
3) I enjoy challenging tasks.

Goal Optimization
Participants are asked to select choices that describe the ways they approach and accomplish goals in their lives. Responses range from 1 = almost never, through 5 = almost always.

Goal Optimization - Self Starter
1) I am the one who gets the ball rolling.
2) I am a self-starter.
3) I take initiative when something needs to get done.

Goal Optimization - Persistence
1) I work diligently to complete my tasks.
2) I find ways to use my resources most efficiently.
3) I devote as much time and energy as needed to complete a task.

Goal Compensation
Participants are asked to select choices that describe the ways they approach and accomplish goals in their lives. Responses range from 1 = almost never, through 5 = almost always.

1) When one approach fails, I try different ways to reach my goals.
2) After a failure, I come up with alternative strategies to accomplish my goals.
3) After I make a mistake, I learn from it and implement new strategies.
4) When one plan fails, I consider what went wrong and how else I can reach my goal.
5) When one strategy doesn't work, I try a new approach.
6) I overcome obstacles by creating new solutions.

Loss-Based Selection
Participants are asked to select choices that describe the ways they approach and accomplish goals in their lives. Responses range from 1 = almost never, through 5 = almost always.

1) I keep projects on the back burner in case another project fails.
2) I keep an eye out for other opportunities I can pursue in case a project fails.
3) When I realize I cannot reach a goal, I quickly move on to new endeavors.
4) When the cost of accomplishing a goal outweighs its benefits, I readily switch to a new goal.

TENFLEX
Participants are asked to select choices that best reflects how frequently they engage in the following behaviors. Responses range from 1 = almost never, through 5 = almost always.

Tenacious Goal Pursuit
1) To avoid disappointment, I don't set my goals too high.
2) When I run up against overwhelming obstacles, I prefer to look for a new goal.
3) The harder a goal is to achieve, the more appeal it has to me.
4) I can be very stubborn in pursuing my goals.
5) When faced with obstacles, I usually increase my efforts.
6) Even when things seem hopeless, I keep on fighting to reach my goals.
7) I stick to my goals and projects even in the face of great difficulties.

Flexible Goal Adjustment
1) When I get into serious trouble, I immediately look at how to make the best out of the situation.
2) I find it easy to see something positive even in a serious mishap.
3) I adapt quite easily to changes in plans or circumstances.

**Self-Efficacy Optimism**
Participants are asked how often they have the following feelings. Responses range from 1 = almost never to 5 = almost always.
1) For each problem I will find a solution.
2) In difficult situations I will find a way.
3) No task is too difficult for me.
4) I master difficult problems.
5) There is no task that is too demanding for me.
6) I always find a solution to a problem.

**Machiavellian**
Participants are asked to rate how much they agree or disagree with the following statements. Responses range from 1 = disagree to 5 = agree.

**Morality**
1) I believe that lying is necessary to maintain a competitive advantage over others.
2) The only good reason to talk to others is to get information that I can use to my benefit.
3) I am willing to be unethical if I believe it will help me succeed.
4) I am willing to sabotage the efforts of other people if they threaten my own goals.
5) I would cheat if there was a low chance of getting caught.

**Control**
1) I like to give the orders in interpersonal situations.
2) I enjoy having control over other people.
3) I enjoy being able to control the situation.

**Status**
1) Status is a good sign of success in life.
2) Accumulating wealth is an important goal for me.
3) I want to be rich and powerful someday.

**Assertiveness**
Participants are asked to indicate how much they agree or disagree with the following statements. Responses range from 1 = strongly disagree to 5 = strongly agree.
1) When I talk with others, I give my real opinions and thoughts.
2) I say what I think.
3) When I have an opinion, I usually say it.
Future Orientation
Participants are asked how often they do the following things. Responses range from 1 = almost never to 5 = almost always.
1) Plan things out one step at a time.
2) Think about all of the possible good and bad things that can happen before making a decision.
3) Think about the consequences before doing something.
4) Make lists of things to do.
5) Make plans before making decisions.
6) See in advance how one thing can lead to another.
7) Think a lot about how my decisions will affect others.
8) Think things work out better if they are planned out in advance.
9) Take big projects and break them down into small steps before starting to work on them.
10) Think it's better to run through all the possible outcomes of a decision in my mind before deciding what to do.

Hopeful Futures
Participants are asked to indicate how they expect the chances for the following to happen in future. Responses range from 1 = very low to 5 = very high.
Life
1) Have a job you like doing
2) Be healthy
3) Have a happy family life
4) Have friends you can count on
5) Be respected in the community
6) Be involved in helping other people
Money
1) Be able to buy the things you need
2) Be able to do the things you want
3) Have a job that pays well
4) Be able to live wherever you want
5) Be safe

Sense of Self
Participants are asked how central the following qualities are to their sense of who they are as a person. Responses range from 1 = not at all central to my sense of self, through 5 = very central to my sense of self.
Movers & Shakers
1) Willing to stand up for what I believe is right
2) Involved in solving community problems
3) Creative or imaginative
4) Politically involved
5) Compassionate, concerned about all kinds of people
6) Unconventional, nonconformist
7) Concerned about justice and human rights
8) Outgoing, sociable
9) Curious

Conventional
1) Fair, unbiased
2) Honest or truthful
3) Responsible, someone others can depend on
4) Reliable, consistent

Personal Values
Participants are asked how important the following are in their lives.
1) Doing what I believe is right, even if my friends make fun of me.
2) Standing up for what I believe, even when it's unpopular to do.
3) Telling the truth, even when it's not easy.
4) Accepting responsibility for my actions when I make a mistake or get into trouble.
5) Doing my best, even when I have a job I don't like.

Positive Youth Development
Participants are asked to indicate how much they agree or disagree with statements or how well
the statements describe them.
Confidence
1) I am happy with myself most of the time.
2) I really like the way I look.
3) All in all, I am glad I am me.
Caring
1) When I see someone being taken advantage of, I want to help them.
2) When I see someone being picked on, I feel sorry for them.
3) When I see another person who is hurt or upset, I feel sorry for them.

Mentoring
Participants are asked to indicate the number of non-parental adults they have known for one or
more years who met a series of criteria that define adult mentors. Responses range from “zero”
to “four or more”.
1) Give you lots of encouragement whenever they see you
2) You look forward to spending time with
3) Talk with you at least once a month
4) Spend a lot of time helping other people

Family/Friends
Participants are asked to indicate how much they agree or disagree with the following
statements. Response choices ranged from 1 = strongly disagree to 5 = strongly agree.
Family
1) Notices when I'm interested in something
2) Talks with me about my interests
3) Encourages me to develop my interests
4) Helps me to learn more about my interests
5) Does not understand why I am interested in the things I am interested in

Friends
1) Talk with me about my interests
2) Encourage me to develop my interests
3) Help me to learn more about my interests

Entrepreneurship Activities
Participants are asked how many times they have been involved in the following entrepreneurship activities.
1) Started a Club
2) Organized people around a cause
3) Devised ways to make money
4) Designed a new product or service
5) Developed a business plan
6) Started a business
7) Bought or sold a company

Extra-Curricular Activities
Participants are asked if they have ever participated in the following activities.
1) 4-H Club
2) Young Professional Organization
3) Entrepreneurship Club
4) Boy/Girl Scouts