



Creative Go-Getters: Antecedents of Entrepreneurial Activities in Engineering Undergraduates

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Abstract:

The purpose of this study is to examine characteristics of incoming engineering students as possible predictors of later participation in entrepreneurial activities. Four characteristics were examined: 1) locomotion, 2) self-evaluation, 3) creative self-efficacy and 4) having a close relative who is an entrepreneur. In September of 2013, a survey was sent to first-year engineering students at a large mid-Atlantic university as part of a larger longitudinal study. A total of 817 students completed the survey with a response rate of 29.1%. The students completed a battery of scales including the creative self-efficacy scale,¹ the locomotion scale, and the assessment scale.² At the end of the survey, students were asked whether or not they had yet considered pursuing a minor in the engineering entrepreneurship minor located at the university. At the end of the survey, students were also asked whether or not they had a close family member who was an entrepreneur and a series of questions concerning their perceptions of entrepreneurship as a career path.

This study examined the following hypotheses: 1) Engineering students who intend to minor in entrepreneurship have higher scores on locomotion and creative-self efficacy and lower scores on assessment. These students will also have more positive perceptions of entrepreneurship as a possible career path. 2) More positive views of entrepreneurship as a career will be positively associated with higher scores on locomotion and creative self-efficacy and lower scores on assessment. 3) Students with a close family member who is an entrepreneur will be more likely to intend to minor in engineering entrepreneurship and have more positive perceptions of entrepreneurship as a career. The results suggest that students who are considered “go-getters” and see themselves as being creative individuals are both likely to know about the entrepreneurship minor early in their academic careers and to aspire to pursue the minor. Students with high locomotion high creative self-efficacy scores also had more positive views of entrepreneurship as a career. Having a close family member who is an entrepreneur was also a positive predictor of a positive view of entrepreneurship as a career

Introduction

In the past decade, engineering entrepreneurship has become increasingly important in the engineering curricula.³ More and more programs are being developed at universities and colleges both nationally and internationally. Innovation and entrepreneurship are seen by many institutions to be critical for our national competitiveness.

The purpose of this study is to examine characteristics of incoming engineering students as possible predictors of later participation in entrepreneurial activities. While several studies exist

that examine whether or not one can predict an individual's entrepreneurial success, no studies were found in the engineering entrepreneurship and the broader entrepreneurship literature that attempts to predict the students who will participate in entrepreneurial activities in an academic setting. This study may be of interest to those who direct or manage entrepreneurship programs in engineering or at the university level. Students who have proclivities towards entrepreneurship activities can be made more informed about the possibilities at their institutions.

Theory of Planned Behavior

In the engineering education literature, several studies have examined the impact of entrepreneurship programs, courses, or other interventions on student characteristics. For example, Reid and Ferguson⁴ examined whether entrepreneurial interventions impacted students' mindsets, in terms of being fixed or something that can be improved. Bilen and colleagues⁵ studied the impact of participation in an entrepreneurship minor on constructs such as self-efficacy, leadership attitude, innovation, and teamwork skills. Ohland and colleagues examined participation in an entrepreneurship program on GPA and student retention.⁶ These are just a few of the examples in the literature where researchers and practitioners have examined the impact of these activities on students.

As mentioned above, no articles were found in the engineering education literature which attempted to predict entrepreneurial behaviors from student characteristics. However, in the broader entrepreneurial literature, some researchers have examined "intention to venture." Much of the literature on intention to venture stems from the theory of planned behavior⁷, which states that behavior is typically preceded by three factors: attitudes towards the behavior, the desirability of the behavior, and the feasibility of the behavior. Similarly, the theory of self-efficacy, developed by Bandura⁸ states that one of the most powerful predictors of behavior is and individual's perceived confidence that he or she could be successful of that behavior.

Krueger and Carsrud⁹ applied the theory of planned behavior to the entrepreneurial realm. The authors argue that intentionality, rather than personality constructs, are most predictive of that behavior. However, they acknowledge that intentionality is impacted by exogenous influences such as an individual's skills, personality, and resources as well as attitudes towards that behavior. As the authors state in a subsequent article, "In its simplest form, intentions predict behavior, while in turn, certain specific attitudes predict intention" (p. 413).¹⁰

The intention to venture literature is interesting in examining what factors impact an individual's likelihood of starting a business or other venture. However, this paper focuses on intentionality at a much earlier stage – the intention of a student to take advantage of resources for entrepreneurship on campus, in this case, an entrepreneurship minor. Figure 1 displays a theory of intention for this process, with the target behavior being participation in an entrepreneurship minor.

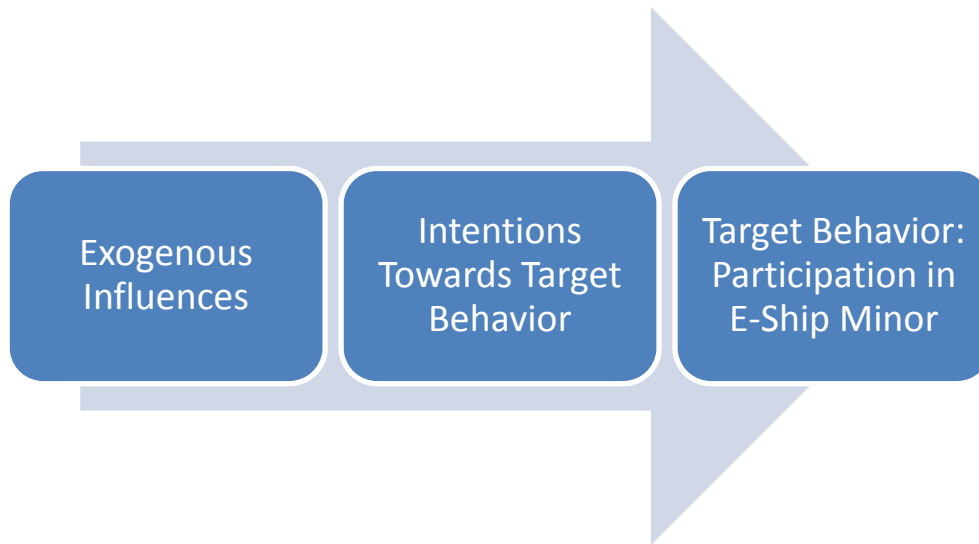


Figure 1: Application of Theory of Planned Behavior towards Intention to Minor in Entrepreneurship (revised from Krueger & Carsrud, 1993)

In Figure 1, whether or not students minor in entrepreneurship will depend on their intentions towards minoring in entrepreneurship, which is moderated by a variety of exogenous influences or antecedents. These exogenous influences can come in a variety of forms, related to both the individual and the environment, as displayed in Figure 2. Characteristics of the person may include personality factors such as whether a person may be considered a risk-taker or creative. Characteristics of the environment may include having a role model, such a family member who is an entrepreneur, or the influence of peers. Other exogenous influences that Krueger and Carsrud discuss include the perceived attractiveness of the target behavior, perceived social norms, and behavioral control. Related to behavioral control is the notion of self-regulation, which is the metacognitive function that drives goals and behaviors and is related to intention. Characteristics of person and environmental factors can potentially interact with one another, as possessing a higher level of a particular attribute may impact how one interacts with the environment. For example, students who are creative may seek out opportunities that allow them to use their creativity. Students who are “go-getters” may be more likely to seek out opportunities within an educational environment and may be more aware of these opportunities.

This study examines several exogenous or antecedent factors related to students’ intention to minor in entrepreneurship. These exogenous factors include several person-related characteristics: locomotion, assessment, and creative self-efficacy. In addition, one environment-related exogenous factor is included: having a relative who is an entrepreneur. While there are certainly other possible environment-related exogenous factors, such as those listed in Figure 2, these are beyond the scope of the paper.

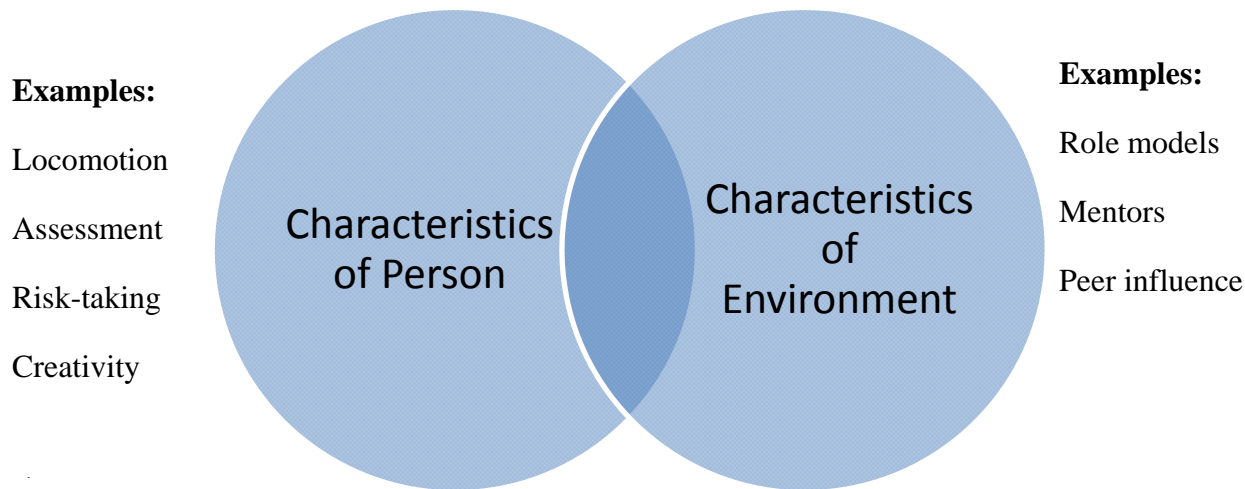


Figure 2: Example antecedents that may impact an individual's likelihood of pursuing an entrepreneurship minor or career

Example exogenous constructs impacting students' pursuit of entrepreneurship minor

Possession of the entrepreneurial mindset is perhaps the ultimate exogenous factor that may influence students' intention to minor in entrepreneurship. Kriewall¹¹ organized a panel session at the annual meeting of the National Collegiate Inventors and Innovators Alliance with the intention of discussing the "defining characteristics of entrepreneurial engineers." The panel identified eleven attributes they felt were necessary for entrepreneurial engineers:

"...integrity, tenacity, ethics, creativity, intuition, a deep knowledge of engineering fundamentals, the ability to engineer products for commercialization, a penchant for lifelong learning, an ability to see how their ideas fit into the larger context of society, and proficiency in communicating his or her ideas."

Kriewall and Mekemson¹² listed a greater number of attributes in the entrepreneurial mindset related to business acumen, understanding customer needs, societal values, and technical depth. The authors provide an extensive list of attributes, skills, and proficiencies that are "indicative of an entrepreneurial mindset" in these four larger categories. Attributes include tolerance for ambiguity, vision, passion, optimism, persistence, creativity, empathy, and prescience.

Examining each of these factors is beyond the scope of this paper in exploring intention to minor in entrepreneurship. However, several constructs related to the social psychology and creativity literature are being explored and are defined further below.

According to Kruglanski and colleagues¹³, locomotion and assessment are two important aspects of self-regulation, the executive function which drives individuals' goals and behaviors. According to the authors, locomotion is the aspect of self-regulation "concerned with movement from state to state...in a straightforward and direct manner..." (p. 794). Individuals who are considered high on locomotion may be termed "go-getters." The construct of locomotion has not yet been studied in entrepreneurship education, although one can easily theorize that those who are high on locomotion would also be likely to pursue careers that would be considered entrepreneurial. The construct of locomotion is similar to "proactiveness," described by Sanchez,¹⁴ as the "tendency to initiate and maintain actions that directly alter the surrounding context" (p. 243). It also involves an "orientation to action" and a "high level of persistence." Sanchez included proactiveness as one of the aspects of the "entrepreneurial drive." Locomotion is also similar to Kriewall's definition of tenacity, or the "stick-to-it-ness that finally gets to the endpoint desired in the face of doubt." It is also similar to Kriewall and Mekemson's attributes of passion and persistence.

Kruglanski and colleagues contrasted locomotion with the construct of assessment. Assessment, or self-evaluation, "constitutes the comparative aspect of self-regulation concerned with critically evaluating entities or states...in relation to alternatives in order to judge relative quality" (p. 794). In other words, individuals who are high assessors often are more critical of themselves and others around them. The relationship between assessment and entrepreneurial intention is less clear on the surface. High assessors often focus on comparing their self towards others, or goals that others have. While this may seem like a quality that entrepreneurs may possess, high assessors also have "more pronounced negative affect and lower optimism and self-esteem," which would be less likely the qualities of successful entrepreneurs. Individuals high on assessment also tend to have more difficulty with decisiveness, as there is often "more extensive consideration of which goal should be pursued" (p. 795). Kruglanski also hypothesizes that individuals who are high assessors may have greater difficulty with task orientation, or "the tendency to attend to an activity or persist...until completion" as they evaluate selections more intently. Assessment seems at odds to Kriewall's definition of tenacity, in that high assessors will have less "stick-to-it-ness" and might be perhaps more likely to say "It can't be done."

A third characteristic examined in this paper is creative self-efficacy, or belief that one is and has the capability of being creative.¹⁵ Prior literature has shown a relationship between creativity and entrepreneurial experiences.¹⁶ Hamidi and colleagues found a "strong association" between scores on a creativity test and students' entrepreneurial intentions and argue for the importance of including measures of creativity in theoretical models of intention. Creativity is mentioned often as one of the critical components for the entrepreneurial mindset or orientation.^{11, 12, 17}

A final exogenous characteristic examined in this paper is having a close family member who is an entrepreneur. Having a family member who is an entrepreneur has been shown in the literature to be related to entrepreneurial intention.¹⁸ Students who have a family member who is

an entrepreneur will likely have a better understanding of entrepreneurship as a possible career path and perhaps be more likely to pursue an entrepreneurship minor.

Research Hypotheses

This study examines three research hypotheses relating to the intention to minor in entrepreneurship. The two self-regulation constructs theorized by Kruglanski and colleagues and creative self-efficacy, proposed by Tierney and Farmer, are the foundation for the first research question explored in this study:

Hypothesis #1: Engineering students who intend to minor in entrepreneurship have higher scores on locomotion and creative-self efficacy and lower scores on assessment. Students intending to minor in entrepreneurship will also have more positive perceptions of entrepreneurship as a possible career path.

Students who are considered “go-getters” who score highly on the locomotion subscale are hypothesized to be more likely to plan to minor in engineering entrepreneurship. Locomotion seems to be an important aspect of the entrepreneurial mindset or orientation, and is similar to constructs often mentioned as critical to entrepreneurship, such as drive, motivation, proactiveness and persistence. The relationship between intention to minor in entrepreneurship and assessment is less clear. However, because of some of the negative aspects associated with assessment, a negative relationship between intention to minor in entrepreneurship and the construct of assessment. In regards to creative self-efficacy, students who believe that they are creative individuals are perhaps more likely to seek out and explore opportunities that enable them to use their creative skills.

While the core purpose of this paper is to examine the relationship between intention to minor in entrepreneurship and several exogenous variables, a second research question will examine the relationship between perceptions of entrepreneurship as a career and these variables:

Hypothesis #2: More positive views of entrepreneurship as a career will be positively associated with higher scores on locomotion and creative self-efficacy and lower scores on assessment.

A final third question of this study will look at one environmental exogenous factor, having a close family member who is an entrepreneur, and the intention to minor in entrepreneurship. This hypothesis is listed below:

Hypothesis #3: Students with a close family member who is an entrepreneur will be more likely to intend to minor in engineering entrepreneurship and have more positive perceptions of entrepreneurship as a career.

Methods:

Context of Study

The study takes place at a large-mid-Atlantic research university. The College of Engineering is quite large, housing twelve undergraduate programs of study. An entrepreneurship minor had previously been housed within the College of Engineering. However, in the past year, the minor has transitioned to a university-wide minor with two clusters housed in the College of Engineering. The entrepreneurship minor currently has five clusters, which are open to students of any major. Two of these clusters are housed within the College of Engineering (Technology-Based Entrepreneurship and Social Entrepreneurship).

At the university, first-year students who intend to major in engineering are given a designation of ENGR. They are not formally admitted into a specific engineering major until the end of their sophomore year. Students can formally choose a minor after their formal major is selected. However, students can begin to take courses towards the minor prior to their major selection.

Participants

In September of 2013, an online survey was sent to 2,808 first-year engineering students the university. Students across both the university's main campus and satellite campuses were invited to participate, provided that they denoted an indication to major in engineering. The survey results discussed in this study were embedded in a larger longitudinal study relating to students' international self-concepts and experiences. Because of the unique experiences of international students, only resident students were invited to participate in the study. In order to increase the response rate, students were informed that ten randomly selected respondents would receive a \$25 gift certificate to an online retailer. Of the 2,808 students invited to participate, a total of 817 students started the survey for a response rate of 29.1%. The start rate was calculated by the number of students who provided information on at least one question. Only data with at least one subscale score, defined further below, was retained for analysis. Incomplete surveys were excluded from analysis. This resulted in a sample size of 712 students, of whom 162 (22.8%) were female and 550 were male (77.2%). The majority of the students (77.5%) were white. A total of 11.9% were Asian American, 5.6% were Hispanic American, and 2.1% were black.

Instrument

After reading the implied consent form, students completed a battery of scales including the creative self-efficacy scale (Tierney & Farmer, 2002), the locomotion scale, and the assessment scale (Kruglanski, et al., 2000). These scales have strong validity evidence and are often used in the psychological literature. In addition, a new scale was created for this study, called the Entrepreneurship as Career scale, which consisted of three items relating to students' attitudes towards pursuing an entrepreneurial career. At the end of the survey, students were asked

whether or not they had yet considered pursuing a minor in engineering entrepreneurship located at the university and whether or not they had a close relative (defined as parent or sibling) who was an entrepreneur. Table 1 provides information about the scales administered in the study, including the number of items on each subscale and the reliability indices calculated from data in the study. Copies of the survey questions specifically developed for this study are available in the appendix.¹

Responses for each item were calculated by scoring the most negative anchor (Strongly Disagree) as a 1 and the most positive anchor (Strongly Agree) as the highest value possible for that particular subscale. For example, for the creative self-efficacy scale, which uses a 7-point scale in the literature, a response of Strongly Agree received a coded score of 7. Subscale scores for each of the four scales were created by adding the coded responses for all items within that scale.

Table 1: Information on scales used in study

Scale	Author	Number of Items	Number of Anchors	Cronbach's Alpha
Creative self-efficacy	Tierney & Farmer (2002)	4	7	0.834
Locomotion	Kruglanski et al. (2000)	12	6	0.845
Assessment ²	Kruglanski et a. (2000)	12	5	0.737
Entrepreneurship as Career	Newly Developed	3	6	0.870

Results:

Table 2 provides descriptive statistics for each of the subscales used in the study. A total of 156 (21.9%) of the students had considered pursuing a minor in entrepreneurship at the university. A total of 152 (21.3%) indicated that they had a close family member who was an entrepreneur. The analyses corresponding to each hypothesis follow below.

Table 2: Descriptive statistics for each subscale

Scale	Minimum	Maximum	Mean	Standard Deviation
Creative self-efficacy	7	24	19.18	3.05
Locomotion	26	72	54.86	8.00
Assessment	21	59	42.49	6.21

¹ The creative self-efficacy scale is available by contacting Tierney and Farmer. Permission was obtained by Tierney and Farmer to use the scale in this research. The locomotion and assessment scales are available by their author online at <http://terpconnect.umd.edu/~hannahk/Scales.html> (downloaded on October 16, 2013).

² The original scale by Kruglanski had six anchors ranging from Strongly Disagree to Strongly Agree. Due to an administrative error, the scale in this scale had only five anchors ranging from Strongly Disagree to Strongly Agree.

Entrepreneurship as Career	3	18	10.00	3.88
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Hypothesis 1: Engineering students who intend to minor in entrepreneurship have higher scores on locomotion and creative self-efficacy and lower scores on assessment. Students intending to minor in entrepreneurship will also have more positive perceptions of entrepreneurship as a possible career path.

Table 3 provides the descriptive statistics for each subscale, comparing those who had identified themselves as wanting to pursue the minor to those that were not considering it at the time of the survey. In order to examine this hypothesis, a Hotelling's *T*-square, a multivariate version of an independent *t*-test, was conducted using subscale scores of locomotion, assessment, and creative self-efficacy as the dependent variables and intent to minor in entrepreneurship as a fixed factor. The model was significant with a Hotelling's *T* equal to 14.95 [$F(3,621) = 4.870, p = 0.002$], which suggests that at least one variable in the model is significantly different between the two groups. Tests of between-subjects effects show that the creative self-efficacy and locomotion scores are significantly different between the two groups.

The results of this analysis support the initial hypothesis that students who intend to minor in engineering entrepreneurship have significantly higher scores on locomotion and creative self-efficacy. However, no significant differences were found on students' assessment scores.

A separate independent *t*-test was conducted to examine whether students who were considering the minor had more positive impressions of entrepreneurship as a career. This test was conducted separately because the construct being examined in this case was substantially different in nature than locomotion, assessment, and creative self-efficacy. The *t*-test showed that students who were considering minoring in entrepreneurship had a significantly more positive perception of entrepreneurship as a career.

Table 3: Descriptive statistics for subscale by students' intent to minor in entrepreneurship

Scale	Students considering minor	Students NOT considering minor	Statistic and p-value
Creative self-efficacy	19.85 (3.20)	19.04 (2.93)	$F=12.377, p<0.000^*$
Locomotion	56.82 (7.83)	54.38 (7.88)	$F =10.435, p=0.001^*$
Assessment	42.86 (7.00)	42.44 (5.97)	$F =0.574, p=0.449$
Entrepreneurship as Career	13.24 (3.31)	9.06 (3.5)	$t=13.19, p<0.000$

*Indicates comparisons that are significant at the 0.05 level.

Hypothesis 2: More positive views of entrepreneurship as a career will be positively associated with higher scores on locomotion and creative self-efficacy and lower scores on self-assessment.

In order to answer this hypothesis, correlations were examined between the subscale scores for creative self-efficacy, locomotion, assessment, and entrepreneurship as career. Table 4 provides the correlation matrix for these variables. Entrepreneurship as Career scores had a weak, positive direct relationship with Locomotion and Creative Self-Efficacy scores. However, the magnitude of these correlations is not large. The largest observed correlation was between locomotion and creative self-efficacy. Entrepreneurship as Career and Assessment did not have a correlation significantly different than zero.

Table 4: Descriptive statistics and Pearson correlations

Variable	M	SD	1	2	3	4
1. Creative self-efficacy	19.18	3.05				
2. Locomotion	54.86	8.00	0.58**			
3. Assessment	42.49	6.21	0.16*	0.08		
4. Entrepreneurship as Career	10.00	3.88	0.20**	0.20**	-0.01	

** Indicates correlations significant at the 0.01 level. * Indicates correlations significant at the 0.05 level.

Hypothesis 3: Students with a close family member who is an entrepreneur will be more likely to intend to minor in engineering entrepreneurship and have more positive perceptions of entrepreneurship as a career.

Table 5 shows a cross-tabulation of having a family member who is an entrepreneurship versus intent to minor in entrepreneurship. A chi-square test of independence showed that there is a significant relationship between having a family member who is an entrepreneur and intent to minor in entrepreneurship [$X^2(1, n=694)=6.77, p=0.009$].

An independent t-test was conducted to examine the second part of this hypothesis, which was examining the differences on the Entrepreneurship as Career variable for those with a family member as an entrepreneur versus those without. The average score for students with a family member as an entrepreneur was $M=11.28$ with a standard deviation of $s=4.15$. The average score for students without a family member as an entrepreneur was $M=9.64$ with a standard deviation of $s=3.73$. Students with a family member as an entrepreneur score had significantly higher scores on the Entrepreneurship as Career [$t(692)=4.672, p<0.000$].

Table 5: Cross-tabulation of having a family member who is an entrepreneur versus intent to minor in entrepreneurship

		Do you have a close family who is an entrepreneur?	
		Yes	No
Intent to minor	Yes	46	110

in entrepreneurship	No	106	432
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Discussion:

Three hypotheses were examined in this study which is primarily focused on examining the variables that relate to intention to minor in entrepreneurship. Hypothesis 1 was partially supported. Engineering students who planned to minor in entrepreneurship had significantly higher reported creative self-efficacy and locomotion. They also had more positive perceptions of entrepreneurship as a career. Their assessment scores were not shown to be significantly different than those who did not intend to minor in entrepreneurship. Hypothesis 2 was also partially supported. Students who had more positive views of entrepreneurship as a career were also more likely to have higher scores on the locomotion and assessment sub-scales, although the magnitude of the relationship was not large. Hypothesis 3 was fully supported as students who report having a family member who is an entrepreneur are more likely to report intention to minor in entrepreneurship. Also, these students have more positive perceptions of entrepreneurship as a career.

This study shows that students who perceive themselves as “creative go-getters” and those who have family members who are entrepreneurial are more likely to aspire to minor in entrepreneurship and are more likely to view entrepreneurship as a positive career goal.

There are some limitations to the study. First, although the sample size is large, the response rate is less than 30%. It is possible that there is a self-selection bias in that students who are more interested in the constructs identified in the study (which included international self-concepts as well as entrepreneurship) may be more likely to both start and complete the study. Second, this study utilizes self-report data. Students may feel the need to rate themselves more positively than may be entirely accurate due to a social desirability tendency, thus resulting in inflating scores for certain measures. However, as Chan¹⁹ notes, social desirability is less likely on measures that are not high-stakes or when there is no “clearly desirable social norm or standard.” Given that the questions of entrepreneurship intent came after the scales in the survey, the true purpose of the scale is not likely to have been evident to the respondents.

An additional limitation of the study is that the data only focuses on intent to minor in entrepreneurship. The study does not provide data on whether the students actually follow through with these early intentions. Intent early in a student’s academic career can easily change as additional pressures and other activities compete for valuable time. A longitudinal study is planned to see if these variables, if identified early in students’ academic careers, will actually predict which students participate in the minor.

There are additional exogenous factors that could impact intent to minor in entrepreneurship. For example, peer influences and role models are environmental influences that could potentially

impact intent to minor in entrepreneurship. Other personality characteristics, such as risk-taking, could also impact this intention. The paper is limited in that only a select number of exogenous factors were explored. Further research should examine other variables that may impact intention to minor in entrepreneurship.

The results of the study have some implications for training entrepreneurs. First, informing students about the availability of entrepreneurship minors and other opportunities is important to do so early in their academic careers. Multiple students commented at the end of the survey that they were not aware of the entrepreneurship minor and that the survey itself had actually provided this information. The information from this study can be used in marketing tools by targeting students who consider themselves to be creative or go-getters.

A final implication is that program directors can specifically target students who consider themselves as being creative or go-getters to participate in the minor. Surveys to first-year students can identify students who consider themselves creative or go-getters to inform them of the opportunities and to encourage them to participate. Information can also be used in marketing tools to target those considered creative or go-getters. The survey tool can also be used by advisors in helping students to identify what opportunities might be the best fit for them.

This study is the first that is known to look at students' intentions to minor in entrepreneurship. While the study supports that students who consider themselves to be go-getters and creative, and who have family members with entrepreneurial backgrounds relate to intentions, there may be many other variables that deserve investigation regarding intentions to minor in entrepreneurship programs.

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Appendix: Items Developed for Study

1. Have you considered minoring in entrepreneurship at [the university]?
2. Do you have a close family member (mother, father, sibling) who is an entrepreneur?
3. Rate your level of agreement with the following items (Entrepreneurship as a Career Subscale)

	Strongly disagree	Moderately disagree	Slightly disagree	Slightly agree	Agree	Strongly Agree
A career as an entrepreneur is attractive to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My professional goal is to be an entrepreneur.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to own my own business some time after I graduate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>