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Exploring Innovative Entrepreneurship and Its Ties to Higher Educational Experiences

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Abstract The purpose of this paper was to explore innovative entrepreneurship and to gain insight into the educational practices and experiences that increase the likelihood that a student would graduate with innovative entrepreneurial intentions. To this end, we administered a battery of assessments to 3,700 undergraduate seniors who matriculated in the spring of 2007; these students attended one of five institutions participating in this study. Results showed that, after controlling for a host of personality, demographic, educational, and political covariates, taking an entrepreneurial course and the assessments faculty use as pedagogical strategies for teaching course content were significantly related to innovation intentions. Implications for higher education stakeholders are discussed.

Keywords Innovation · Quantitative · College student · College impact

Recent economic crises have generated renewed national interest in understanding the relationship between education and innovative entrepreneurship and its role in meeting the

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economic challenges facing the twenty-first century. Embodying and further complicating this relationship are entrepreneurs whose educational experiences range from dropping out of Harvard (e.g., Bill Gates, founder of Microsoft) to receiving degrees from some of the top-ranked business schools in the country (e.g., Phil Knight, founder of NIKE, Stanford M.B.A.). Emerging from these examples of innovative entrepreneurs are questions concerning the relationship between higher educational and innovative entrepreneurship. How necessary is college-going to developing an interest in becoming an innovative entrepreneur? Is innovation something that can be nurtured in college? What can colleges and universities do to help students develop innovative entrepreneurial intentions? Questions like these have led institutional stakeholders to revisit educational practices and their effectiveness at inspiring students to want to create innovative, entrepreneurial solutions for the challenges facing future generations.

The purpose of this study is unique: to explore innovative entrepreneurship and to gain insight into the educational practices and experiences that increase innovative entrepreneurial intentions among undergraduate seniors. To this end, we administered a battery of assessments to 3,700 undergraduate seniors who matriculated in the spring of 2007; these students attended one of five institutions participating in this study. It is our hope that this study will not only contribute to the emerging discourse on what constitutes an innovative entrepreneur, but will equip educators with the tools needed to begin discussions about designing curricular and co-curricular experiences that help students cultivate innovation and subsequently apply it in an entrepreneurial setting.

Theoretical Framework

We adopted an interdisciplinary approach for framing our exploration of the relationship between higher education and innovative entrepreneurship. First, we turned to economists and organizational management experts to explain innovative entrepreneurship, its ontology, and its importance for consideration as a higher education learning outcome. Emerging from these explanations was the notion that the essence of innovative entrepreneurship, often measured by the number of patents received or venture capitalist dollars procured, could not necessarily be captured as a higher education outcome, as few undergraduate students would have had the opportunity to design and bring new products and processes to the market. As a result, we turned to Ajzen (1991, 2002) and to Shane (2003) to theoretically inform the creation of our outcome measure, undergraduate students' intentions to innovate as entrepreneurs. With intention to innovate situated as our outcome of interest, we turned to college impact frames for organizing the empirical literature used to justify the variables included in the final analytical models. We concluded this section with the study's conceptual framework.

Innovative Entrepreneurship

What is innovative entrepreneurship? Defining innovation, economists refer to the entire process of inventing a new product, modifying it to appeal to consumer tastes, and then manufacturing and marketing it. As such, an innovation is not only novel but also must create value (Tidd et al. 1997). When applied to entrepreneurship, experts have attempted to differentiate entrepreneurship that is innovative from other, more common forms of entrepreneurship, such as that which is replicative. For example, Baumol et al. (2007a)

defined replicative entrepreneurs as "hav[ing] no difficulty coming up with the ideas for their businesses: they simply copy what some others have done," being sure to pick a business model already in the marketplace that is "best suited to their talents, experience, and interests" (p. 107). Alternatively, an innovative entrepreneur "provides a *new* product or service or ... develops and uses *new* methods to produce or deliver existing goods and services at lower cost" (Baumol et al. 2007a, p. 3). Almost by definition, replicative entrepreneurship will be more common than innovative entrepreneurship, and perhaps because of the preponderance of the former, most empirical studies focus on understanding replicative entrepreneurs and their related educational experiences. With the few exceptions, including studies conducted by Colyvas and Powell (2007), Mars et al. (2008), and Mars and Lounsbury (2009), there is a paucity of research studies designed to explore the educational experiences that contribute to innovative entrepreneurship.[1]

Entrepreneurship Education

The literature on entrepreneurship has a long and distinguished lineage, going back at least to the work of Richard Cantillon (1755). But it is only with the writings of J. B. Say, beginning with the first edition of his Treatise on Political Economy (1803; English translation 1827), that we find the crucial distinction between innovative entrepreneurship and entrepreneurship that simply replicates the work of earlier founders of business firms. This distinction subsequently disappeared from the literature until the twentieth century, with Joseph Schumpeter's path breaking analysis (1911; English translation 1936) that hammered home this critical differentiation. Together with the subsequent contribution of Israel Kirzner (1973), Schumpeter's analysis provides important insights into the unprecedented growth accomplishments of the modern market economies.

Schumpeter's analysis focuses on the role of the entrepreneur in undermining equilibria by constantly introducing new products, new processes, new markets, and new forms of organization. These activities are the source of the "creative destruction" that promotes the general welfare and unceasingly disturbs the economic status quo. Kirzner completes the story of the economy's dynamism by focusing on the other side of the matter: the entrepreneur's constant search for profitable opportunities offered by markets in disequilibrium. The profits of such activities are provided by innovative arbitrage that restores the economy's equilibrium. Both Schumpeter and Kirzner thereby bring out the importance of capable innovative entrepreneurs.

Extending this work, Baumol (2004) frames the education of innovative entrepreneurs at the university level as an intentional process, designed in such a way as to avoid a heavy reliance on the replication and inculcation of in-the-box thinking and standardized ways of approaching the marketplace from a traditional business perspective; the problem with this "traditional perspective" is that it may impede the development of creative thinking and behavior that is necessary for innovation. While such traditional work may be necessary to advance existing products and processes, their initial discoveries may require unorthodox approaches.

[1] There is another type of entrepreneurship, *social entrepreneurship*, which is of enormous importance for the general welfare, though it is not the central concern of this paper. This arena of entrepreneurship focuses on encouraging and assisting the world's enormous impoverished population, for whom the model of entrepreneurship provided by technologically advanced economies is not always relevant. The educational needs of those who engage in social entrepreneurship, like the needs of its beneficiaries, are very different from those of the innovative entrepreneurs in developed economies. For excellent discussions of social entrepreneurship, see Lounsbury and Strang (2009) and Mars (2009).

Theory of Planned Behavior

We adopted tenets of the theory of planned behavior (Ajzen 2002, 1991) to validate our decision to interrogate innovation intentions rather than innovation itself. The theory of planned behavior posits that behavior is ultimately a function of intention, which is comprised of three reciprocal components: (1) attitude toward the behavior, (2) subjective norm, and (3) perceived behavioral control (see Ajzen 1991 for a more detailed presentation of each of these components). A major assumption underscoring this theory is that individuals have volitional control over their behaviors; those who intend to perform the behavior are more likely to perform the behavior than those with no such intentions.

We used the theory of planned behavior (TPB) to guide our study for two reasons. First, previous scholars interested in the effects of entrepreneurship education on outcomes similar to innovation suggested its use—either solely or in combination with other frameworks (Fayolle et al. 2006; Liñán 2004). Second, for the purposes of this study, we suggest that, at the time of survey administration, the majority of our sample comprised of graduating seniors had yet to have the opportunity to demonstrate innovative entrepreneurship (e.g., receive patents, procure resources from venture capitalists); making our decision to examine innovative entrepreneurship intentions appropriate.

The entrepreneurship literature guided our focus on the specific behaviors associated with innovative entrepreneurship activity. Specifically, innovative entrepreneurship has been viewed as a process composed of identifying new business-related opportunities, acquiring the resources necessary to take advantage of the identified opportunity, developing a strategy to take advantage of the opportunity, and developing a new entity to take advantage of the opportunity (see Shane 2003, for a review). The strength of respondents' intention to engage in these behaviors thus reflects their innovative entrepreneurship intentions.

Review of the Literature

We began this exploration of the literature by narrowing our scope, examining information only directly related to innovative entrepreneurship and those educational experiences designed to spur its development. From this process, we quickly learned that this relationship was often deconstructed and subsumed or embedded within research delineating the differences between types of entrepreneurship (e.g., replicative vs. innovative), the relationship between innovative entrepreneurship and its role in understanding the marketplace, or on general entrepreneurship education. How educational experiences affected innovative entrepreneurship was rarely, if ever, examined in its own right; those pieces that addressed this relationship tended to be more conceptual in nature, lacking the empirical support needed to substantiate claims. For these reasons, we framed our investigation of the literature by drawing from a variety of conceptually-based sources, including work summarizing the differences between types of entrepreneurship and those which more generally address entrepreneurship education.

Research on entrepreneurship education varies in focus and includes: conceptual pieces that serve to shape definitions of entrepreneurship education; thought-pieces designed to explore whether entrepreneurship can be taught; anecdotal evidence of best practice models reflecting "successful" curricular designs that emphasize entrepreneurship education; investigations into educational practices most conducive to producing high-performing entrepreneurs; and studies of the types of students enrolling in entrepreneurship education programs (see Béchard and Grégoire 2005; De Faoite et al. 2003; Garavan and

O'Cinneide 1994; Gartner and Vesper 1994; Matlay 2005; Raffo et al. 2000; Sexton and Bowman 1984; Solomon 1991; Vesper and Gartner 1997; Vesper and McMullan 1988). Of these five categories, we will concentrate on the latter four, as these are the most germane to the purposes of this study. At the end of this section, we provide the central research question guiding this study.

Nature Versus Nurture: Can Innovative Entrepreneurship Be Taught?

Researchers have long disagreed about whether or not entrepreneurship can be taught and, thus, is a malleable skill, an expression of a personality trait such as risk-taking that must be in-born or established at an early age, or some combination of both. Although few would dispute that education is integral to the success of a nation's economic development (McMullan 1988; McMullan and Long 1987), many would suggest that innovation is not something that necessarily can be taught, clinging to the mantra, "you either have it or you don't."

Since the field of innovative entrepreneurship is relatively new, advocates for linking entrepreneurship education to innovation are beginning to make such an argument: "Education and training ... play a key role in the innovation arms race that is essential to sustain economic growth in any economy" (Baumol et al. 2007b, p. 268). Business firms cannot succeed "unless their managers and workers have the skills necessary to generate innovations or, at the very least, to recognize and purchase the rights to innovations developed by others" (Baumol et al. 2007b, pp. 268–269).

Many of these arguments emerge from studies of general entrepreneurship education and its role in teaching the entrepreneurial skills needed to be effective and productive citizens in a capitalist economy. A survey of entrepreneurship education research published between 1985 and 1994 concluded that entrepreneurship can be taught, and that educational programs can positively influence an individual's entrepreneurial attributes (Gorman et al. 1997). In addition, there appears to be a positive relationship between education and successful entrepreneurial ventures, manifested by start-up companies and self-employment (Chilosi 2001). Credit for such successes can be traced to entrepreneurship education, providing not only didactic knowledge needed for such endeavors but also giving students the confidence to assume the risks inherent to business ownership (Kourilsky and Walstad 2000).

The relationship between entrepreneurship education and entrepreneurial success has also been established by correlating degree attainment with successful performance indicators, such as growth, profits, or earning power. In short, van der Sluis et al. (2005) found that the higher the level of an entrepreneur's education—through the baccalaureate level—the higher the level of performance of his or her venture. Weaver et al. (2006) echo this assertion, stating that the "highest levels of entrepreneurship" are associated with "individuals with at least some college education," but education beyond a bachelor's degree "has generally not been found to be positively linked to entrepreneurship" (Weaver et al. 2006, p. 113).

Based on this part of the review, we included measures of personality as model covariates. This strategy enabled us to differentiate between the amount of variance in the criterion (i.e., intention to innovate) explained by variables measuring personality (i.e., nature) from those measuring higher education experiences, course-taking behaviors and educational practices. We turn now to a discussion of these experiences.

Curriculum

Exposure to relevant, intentionally-designed curricula is also important for the teaching and learning of entrepreneurial skills as well as attributes associated with becoming a

confident businessperson. For example, Kourilsky and Esfandiari (1997) developed and assessed the New Youth Entrepreneur curriculum, a series of 12 educational modules geared toward high school students that contain instructional materials, learning activities, and exercises designed to teach key elements of entrepreneurship. When teachers used this curriculum one period a day for a semester, it significantly influenced the ability of African American high school students from a lower socioeconomic neighborhood to acquire entrepreneurship concepts and skills.

Other studies have established those curricular components needed to successfully develop entrepreneurial skills. Examples include courses in negotiation, leadership, new product development, creative thinking, and introduction to technological innovation (McMullan and Long 1987; Vesper and McMullan 1988); curricular and co-curricular opportunities to increase awareness of entrepreneurial career options (Donckels 1991; Hills 1988); sources of venture capital (Zeithaml and Rice 1987; Vesper and McMullan 1988); techniques for protecting ideas through patents and other measures (Vesper and McMullan 1988); ambiguity tolerance (Ronstadt 1987); the characteristics defining the entrepreneurial personality (Hills 1988; Hood and Young 1993; Scott and Twomey 1998); and the challenges of each stage of venture development (McMullan and Long 1987; Plaschka and Welsch 1990).

In addition to providing curricular opportunities for developing entrepreneurial skills, courses in entrepreneurship must also "enhance self-confidence and self-esteem" and help students "simply to understand entrepreneurship and the role it plays in our society" (Rabbior 1990, p. 54). Effective entrepreneurship programs can achieve these goals through the use of several criteria such as supporting nonlinear thinking, focusing on community integration, and encouraging entrepreneurial ventures and initiatives (Rabbior 1990). Similarly, entrepreneurship education programs must address the student's sense of self-efficacy (Gibb 1996; Sexton et al. 1997).

Clearly, curriculum matters with regard to successfully training entrepreneurs. As a result, we included questions that asked respondents about their major and, more specifically, about their course-taking experiences.

Educational Practices

With regard to pedagogy, a series of anecdotal and empirical pieces have isolated the educational practices most effective in training entrepreneurs. Synthesizing information across these sources, it becomes clear that reality-based and experientially-based teaching practices are the best instructional methods for achieving desired results (Plaschka and Welsch 1990; Porter and McKibbin 1988). Examples of reality-based practices include: the use of business plans (Gartner and Vesper 1994; Hills 1988; Vesper and McMullan 1988); opportunities for student business start-ups (Hills 1988); consultation with practicing entrepreneurs (Solomon et al. 1994); interviews with entrepreneurs and environmental scans (Solomon et al. 1994); "live" cases (Gartner and Vesper 1994); and field trip films (Klatt 1988). Experientially-based methods not based in reality included computer (Brawer 1997) and behavioral simulations (Stumpf et al. 1991).

Baumol (2004) has suggested that universities use a combination of two approaches to educate innovative entrepreneurs. First, students should work on research projects that give them practical "mastery of the currently available body of analysis" that is important for work in industry (Baumol 2004, p. 25). Second, students need "more free-wheeling exercise of the imagination in the unorthodox directions from which the technical breakthroughs are more likely to emerge" (2004, p. 25). The challenge facing universities

trying to design better programs for innovative entrepreneurs is how to provide the appropriate level of technical training while avoiding "the inculcation of standardized and unimaginative ways of thinking" (2004, p. 26).

What these studies show is the array of instructional methods posited for helping students become innovative entrepreneurs. Common across these methods is the idea that unorthodox, experience-based practices that enable students to apply didactic knowledge to real-world solutions seem to be the best positioned to accomplish the goal of graduating innovative entrepreneurs, characterized by self-confidence, imagination, and a mastery of knowledge, awareness, and skills needed to be highly successful. In the development of our survey, we intentionally asked participants about innovative teaching practices, including those enacted outside the classroom.

Entrepreneurship Students

Colleges and universities commonly place their entrepreneurship education programs within their business schools (de Bruin et al. 2006; Solomon 2007, 1991). However, a growing movement has aimed to engage non-business students who have entrepreneurial attributes and have expressed interest in entrepreneurial pursuits (Levenburg et al. 2006). For example, there is a growing trend in entrepreneurship courses geared for art, engineering, and science students (Kuratko 2005). Moreover, schools of agriculture, engineering, and arts and science offer entrepreneurship courses, sometimes with "minimal or no involvement by business school entrepreneurship faculty" (Katz 2003, p. 295). As a result of broad student interest and the overall importance of entrepreneurship to the economy, the Kauffman Panel on Entrepreneurship Curriculum in Higher Education (2008) has argued for the need to teach entrepreneurship across the curriculum. The Panel (2008) advises, however, "Entrepreneurship cannot be a 'one size fits all' discipline. Each program will have a particular set of outcomes, a defined target audience, and will fit into a local ecosystem" (p. 9).

These studies highlight the importance of, again, thinking "out-of-the-box" about the assumptions we hold when approaching students "most likely" to have interest in and benefit from entrepreneurship education. The sample for this study consisted of all students intending to graduate in the spring of 2007, regardless of major or discipline. Such broad representation will hopefully add some texture to the study, as we welcome the diversity of perspective often emerging from interdisciplinary approaches to learning.

Conceptual Framework

We adopted Astin's (1991) Input-Environment-Outcome model for framing our study. Our series of input variables include: personality, race, gender, socioeconomic status, age, and family history with entrepreneurship. Environmental variables were deconstructed into two major categories: descriptive educational *characteristics* and higher education *experiences*. Comprising our construct designated as descriptive educational characteristics were variables measuring grade point average, political orientation, and college major. For the construct designated as higher education experiences, we include involvement controls (e.g., fraternity or sorority membership, participation in student clubs, participation as a resident assistant, participation in a research experience, participation in an internship experience) and curricular experiences (e.g., enrollment in an entrepreneurship course, and perceptions of faculty practices). Our outcome for this study was intention to innovate after graduation.

Method

Grounded in the aforementioned literature, we developed the central research question guiding our study: What educational practices and experiences influenced students' innovative entrepreneurial intentions?

Sample

The sample for this study consisted of 4,731 seniors intending to graduate from one of five participating U.S. institutions in the spring of 2007. Response rates for this sample reached 23.6%. The participant institutions were selected based on their willingness to participate in the study. Of the five institutions, four were considered Research Comprehensive Universities; two were private, and each represented different parts of the country: Northeast, Midwest, South and Southwest. (Incidentally, only 15 students participated from the small private institution, so they were included in the analyses but not included in university-level model verifications detailed later in the paper.) The total sample with complete and usable responses was 3,700 seniors.

In order to investigate whether nonresponse bias might be a problem in this sample we investigated the relationships between the month in which the student responded to the survey and their characteristics, including grade point average, SAT score, political beliefs, major, race, gender, and citizenship status for each university, since evidence of such a relationship could suggest that students who could have responded later (the non-respondents) were different from those who did respond. We found little evidence to suggest nonresponse, as the observed associations were well within what would have been expected by random chance.

Most of the sample (63.9%) self-identified as female and most self-identified as White (70.8%). Almost half (49.6%) were 22–25 years old. Table 1 summarizes other important demographic characteristics of the sample as well as the proportions of students whose parents ever started a business, the proportions majoring in different subject areas, and a summary of the (possibly multiple) forms of payment the students used for their education.

Of particular importance to this study was the variable measuring entrepreneurship course-taking behaviors. Of the entire sample, just over one in five students had enrolled in an entrepreneurial course. Although students with business-related majors were more likely to have taken an entrepreneurial course (22.7% of 1287 such majors), the course-taking rate was comparable for non-business majors (19.5% of 2413 such majors).

Measures

Two measures were administered to students. The first is the Ten Item Personality Measure (TIPI; Gosling et al. 2003) that assesses personality dimensions, including Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to New Experiences. Commonly referred to as the Big-Five framework, these personality dimensions are the most widely and extensively researched (for reviews, see John and Srivastava 1999; McCrae and Costa 1999), although they have not been accepted universally (Block 1995). In terms of reliability and validity, a comprehensive review of the TIPI was performed, with the authors concluding that the "TIPI reached adequate levels in each of the criteria against which it was evaluated: convergent and discriminant validity, test–retest reliability, patterns of external correlates..." (Gosling et al. 2003, p. 20). See Table 2 for summary statistics for these variables.

Table 1 Summary statistics for variables used in regression modeling

Variable	M	SD	Min	Max
Outcome				
Intention to innovate[a]	0.00	1.00	−2.87	1.81
Personality				
Extroversion[a]	0.00	1.00	−2.55	1.70
Agreeableness[a]	0.00	1.00	−3.56	1.88
Conscientiousness[a]	0.00	1.00	−4.23	1.21
Emotional stability[a]	0.00	1.00	−3.12	1.71
Openness to experience[a]	0.00	1.00	−4.50	1.81
Descriptive				
Gender				
Male	0.36	0.48	0.00	1.00
Female	0.64	0.48	0.00	1.00
Race				
African-American	0.05	0.21	0.00	1.00
Asian/Asian-American	0.12	0.32	0.00	1.00
Hispanic/Latino	0.08	0.27	0.00	1.00
Native American	0.02	0.13	0.00	1.00
White	0.73	0.44	0.00	1.00
Multi-racial	0.04	0.19	0.00	1.00
Other	0.03	0.18	0.00	1.00
Socioeconomic status[a]	0.00	1.00	−2.35	2.67
Age[a]	0.00	1.00	−3.63	2.99
Family exposure to entrepreneurship	0.60	0.49	0.00	1.00
Educational/political				
Grade point average[a]	0.00	1.00	−3.89	1.42
Political views[a]	0.00	1.00	−2.67	1.87
College Major				
Accounting	0.03	0.16	0.00	1.00
Advertising	0.08	0.27	0.00	1.00
Banking	0.02	0.14	0.00	1.00
Computer	0.03	0.16	0.00	1.00
Consulting	0.02	0.15	0.00	1.00
Education	0.11	0.31	0.00	1.00
Entertainment	0.05	0.22	0.00	1.00
Environment	0.02	0.13	0.00	1.00
Finance	0.04	0.19	0.00	1.00
Government	0.03	0.18	0.00	1.00
Health care	0.15	0.35	0.00	1.00
Hospitality	0.01	0.09	0.00	1.00
Insurance	0.00	0.04	0.00	1.00
Internet	0.00	0.07	0.00	1.00
Legal	0.05	0.21	0.00	1.00
Nonprofit	0.05	0.22	0.00	1.00

Table 1 continued

Variable	M	SD	Min	Max
Real estate	0.02	0.13	0.00	1.00
Retail	0.01	0.09	0.00	1.00
Other	0.29	0.45	0.00	1.00
Involvement				
Participate in fraternity/sorority	0.15	0.35	0.00	1.00
Club/team leadership	0.42	0.49	0.00	1.00
Participate in research	0.26	0.44	0.00	1.00
Resident assistant	0.15	0.36	0.00	1.00
Participate in internship	0.58	0.49	0.00	1.00
Entrepreneurial class				
Enroll in entrepreneurial class	0.21	0.40	0.00	1.00
Perceptions of learning environment				
Challenging learning environments[a]	0.00	1.00	−4.01	2.71
Connecting experiences[a]	0.00	1.00	−4.85	2.72
Personal relationships with faculty[a]	0.00	1.00	−3.90	2.46
Assessments encouraging argument development[a]	0.00	1.00	−4.24	2.82
Assessments encouraging innovative approaches to problem solving[a]	0.00	1.00	−4.31	3.04
Time students spend on academic work[a]	0.00	1.00	−3.02	1.25
Academic work pushes out of comfort zone[a]	0.00	1.00	−1.63	1.78

[a] These variables are constructed as z-scores, with mean 0 and standard deviation 1

The second measure was an assessment loosely based on the WNS Student Experiences Survey (WSES), developed by Pascarella et al. (2006, 2004, 2005). We used selected items from the WSES, in addition to items piloted for the purposes of this study, to construct scales of student experiences in college and their relationship to intention to innovate. Taken together, items from these surveys formed five-point ordinal scales that measured several aspects of the college student experience, including curricular and co-curricular dimensions.

We then conducted exploratory factor analysis on these scales, which yielded a six construct solution. The first factor, intention to innovate, served as the criterion for the study. The remaining five factors comprised variables measuring student perceptions of learning environments, including perceptions of challenging learning environments, connecting experiences, personal relationships with faculty, assessments encouraging argument development, and innovative classroom practices. In addition, two single-item indicators were also used to measure faculty practices, such as the amount of time students spend on academic work and perceptions of academic work pushing students out of their comfort zones. See Table 2 for results of this factor analysis, including item loadings and reliability estimates.

Analysis

Categorical predictors such as race and major were coded in the model using effect codings. This implies that a coefficient for a particular group represents the expected difference in the response of being in that group compared to an overall level (see, for

Table 2 Factor loadings and reliability for measured variables

Scale and individual item measures	Loading	Alpha
Dependent varialbe		
Intentions to innovate[a]		0.83
Developing a strategy to direct your and others' efforts with the goal of taking advantage of a new business-related opportunity (such as developing a business plan)	0.88	
Developing a new entity to take advantage of new business-related opportunities (for example, a team organization devoted to the new opportunity)	0.86	
Acquiring the resources necessary to take advantage of a new business-related opportunity (such as financial resources or expertise)	0.82	
Identifying new business-related opportunities (such as a new product or service people need that is not currently available or a more effective way of producing or running an organization)	0.72	
Independent variables		
Challenging learning environments[b]		0.88
Faculty challenge my ideas in class	0.75	
Faculty ask me to point out any fallacies in basic ideas, principles, or points of view represented in the course	0.72	
Faculty ask me to argue for or against a particular point of view	0.71	
Faculty encourage me to explore original ideas	0.69	
Faculty challenge me to think outside of the box to create solutions to problems presented in class	0.65	
Faculty ask me to show how a particular course concept could be applied to an actual problem or situation	0.59	
Faculty ask challenging questions in class	0.06	
Connecting experiences[b]		0.87
My out-of-class experiences had a positive influence on my intellectual growth and ideas	0.84	
My out-of-class experiences helped me to connect what I learned in the classroom with life events	0.82	
My out-of-class experiences helped me translate knowledge and understanding from the classroom into action	0.81	
My out-of class experiences had a positive influence on my personal growth, attitude, and values	0.80	
Courses helped me to see the connections between my intended career and its broader effect on society	0.05	
Personal relationships with faculty[b]		0.82
My non-classroom interactions with faculty had a positive influence on my personal growth, attitudes, and values.	0.87	
My non-classroom interactions with faculty had a positive influence on my career goals and aspirations.	0.84	
Since coming to this institution, I developed a close personal relationship with at least one faculty member.	0.77	
Assessments encouraging argument development[c]		0.79
Exams or assignments required me to argue for or against a particular point of view and defend an argument	0.76	
Exams or assignments required me to point out the strengths and weaknesses of a particular argument of point of view	0.73	

Table 2 continued

Scale and individual item measures	Loading	Alpha
Exams or assignments required me to compare or contrast topics or ideas for a course	0.71	
Exams or assignments required me to write essays and/or solve problems	0.55	
Assessments encouraging innovative approaches to problem-solving		0.76
Exams or assignments required me to create innovate solutions to presented problems[c]	0.70	
Creating solutions to problems[d]	0.68	
Exams or assignments required me to use course content to address a problem not presented in the course[c]	0.61	
Applying new theories to practices problems or in new situations[d]	0.56	

[a] Items based on the following five-point scale: Indicate how effective you believe you are in each of the following areas: 1 = extremely ineffective, 2 = somewhat ineffective, 3 = neutral, 4 = somewhat effective, 5 = extremely effective

[b] Items based on the following five-point scale: Indicate your level of agreement/disagreement with each of the followings statements: 1 = strongly disagree, 2 = somewhat disagree, 3 = neutral, 4 = somewhat agree, 5 = strongly agree

[c] Items based on the following five-point scale: Indicate how often you experienced the following: 1 = never, 2 = rarely, 3 = occasionally, 4 = often, 5 = very often

[d] Items based on the following five-point scale: Select the response that best fits the frequency with which faculty or coursework emphasized these activities: 1 = not at all, 2 = very little, 3 = some, 4 = quite a bit, 5 = very much

example, Simonoff 2003). Effect codes enable more robust interpretations of categorical covariates; rather than compare effects of an indicator variable against its reference group (e.g., Asian students as compared to White students), effect codes compare an indicator (Asian students) to (roughly) the overall group mean (all students). This technique is especially appropriate for interrogating race, as such a process enables raced subgroups to be compared to each other and does not position responses of the white students (often the social identity group comprising the numerical majority of respondents) as normative—the standard against which all other race effects are interpreted.

Since all of the variables (including the criterion) were either standardized or were indicator variables or were variables that were effect coded, coefficients could be interpreted as effect sizes. In particular, coefficients for standardized variables represented the estimated change in standard deviations of intention to innovate corresponding to a one standard deviation change in the independent covariate, holding all else in the model fixed. Similarly, coefficients for indicator variables represented the estimated difference in standard deviations of intention to innovate, corresponding to being in the group versus not being in the group, holding all else in the model fixed. Finally, as noted earlier, coefficients for effect coding variables represent the estimated difference in standard deviations of intention to innovate, corresponding to being in the group versus an overall level, holding all else in the model fixed.

We used linear regression techniques to estimate the net effects of inputs and collegiate environments on intention to innovate. Using this approach enabled us to investigate the impact of each variable on intention to innovate. Model 1 examined the outcome as a function of personality covariates. Model 2 accounted for other demographic covariates, such as race, gender, socioeconomic status, age, and family history with entrepreneurship.

In Model 3, we added self-reported grade point average, political orientation, and college major. For Model 4, we included involvement covariates, such as participation in Greek organizations, clubs other than Greek organizations, research assistantships, resident assistantships, and college internships. Model 5 included our measure of course-taking, enrollment in an entrepreneurship course. Finally, the learning environment measures, including 5 factors and 2 single-item indicators, were added to Model 6.

A number of statistical tests were performed, and residual plots were examined, in order to investigate assumptions of normality, constant variance, and independence. Residual plots exhibited a "striping" effect, corresponding to non-normality of the residuals. Since the criterion, intention to innovate, is a linear combination of four measures, each of which takes on five values, this variable can take on $5^4 = 625$ possible values. However, since many fewer specific combinations of responses occurred a majority of the time, most occurrences of the intention to innovate variable concentrated on a few numerical values, implying an error distribution that is not consistent with normality.

Further, residuals from the fitted regression models exhibited asymmetry, with a left tail longer than would be expected under normality. For these reasons, we validated the linear models by comparing them to proportional odds models fitted to each individual ordinal scale variable. Variance inflation factors for all of the predictors used were small (less than 2.8), indicating that multicollinearity was not a problem in the data set.

We also verified that there were no deleterious effects on the models caused by the respondents coming from different universities. This resulted in three model verifications: First, we were able to verify that standard error adjustments for students nested within particular institutions were not required for these data. Second, we were able to compare student responses from each university to those from each of the other universities. In this way, it was possible to get an assessment of how well the reported results would generalize to other university settings. Third, we accounted for potential differences between universities directly by fitting university as a random effect in a linear mixed effects model and confirming that the implications of the model were unchanged.

Limitations

Several limitations are worth mention. First, we surveyed students at only one time point, making it difficult to address how college influences the development of innovation intentions and whether these intentions remain over time.

Second, we administered surveys to students enrolled at one of only five institutions whose decision-makers held interests similar to those of the research team; all stakeholders were specifically interested in understanding educational experiences and their influence on entrepreneurial intentions that were innovative as opposed to replicative or social. Generalizations from these data need to be made with caution.

Third, this study emerged from a larger research effort designed to interrogate links between educational experiences and innovation intentions among U.S. students and their peers from other countries, namely Germany and China. As a result of systemic differences in educational delivery processes among countries, we needed to measure "major" in a way that was accessible to all students, especially those outside of the United States. Therefore, our measurement categories for college major were a bit unorthodox, running the risk of not picking up on nuances distinctive to the experiences of U.S. undergraduates and known for influencing outcomes similar to innovative entrepreneurial intentions (see, for example, Powell and Snellman 2004). However, any outcome variability explained by major was accounted for in the regression models which were primarily designed to control

for a host of covariates, including major, in order to isolate the effects of educational practices on entrepreneurial innovation intentions.

As an exploratory study examining newly-emerging idea, innovative entrepreneurship, this effort was intended to broadly identify educational practices and experiences germane for understanding innovative entrepreneurial intentions. Clearly, more empirical work is needed to explore nuances related to this idea, including, for example, a robust examination of other curricular covariates hypothesized for their influence on innovative entrepreneurial intentions. This study only included one measure for course-taking, enrollment in an entrepreneurial course.

Results

Model Summary Estimates

Model summary estimates are provided in Table 3. The table gives the adjusted R^2 value and standard error of the estimate $\hat{\sigma}$ (where σ is the standard deviation of the error term) for each model. It also gives the AIC value for each model. AIC is an information criterion that explicitly balances goodness-of-fit with parsimony (Sheather 2009), with smaller values corresponding to preferred models. Differences in AIC of roughly 5 or more indicate meaningful differences. Since it is only differences in AIC that matter, all of the given AIC values are given as the amount above the minimum AIC value among all models examined. Table 3 also gives partial F-tests (with associated tail probabilities) comparing each model to the simpler one fit before it (that is, comparing Model 2 to Model 1, Model 3 to Model 2, and so on).

Adding an additional class of predictors at each stage produced a model with improved performance, with only the addition of the covariates based on involvement (Greek organizations, research assistantship, and so on, constituting the difference between Model 3 and Model 4) producing only a marginal improvement. Model 6 accounted for roughly 25% of the variability in the criterion. The value of $\hat{\sigma} = 0.864$ implied that the model can predict intention to innovate to within roughly ± 1.73 standard deviations 95% of the time.

Model Iteration Estimates

Table 4 gives the coefficients from each of the model fits. Model A comprised of personality covariates explained 13.4% of the variance in the criterion. Compared to introverted students, extroverted students were significantly more likely to intend to innovate

Table 3 Summary of model fitting for least squares regressions with intention to innovate response variable

	Added covariates	R^2_{adj}	$\hat{\sigma}$	AIC	F	p
Model 1	Personality	0.13	0.93	519.3		
Model 2	Descriptive	0.19	0.90	295.5	25.10	$<10^{-15}$
Model 3	Educational/political	0.22	0.88	164.8	8.65	$<10^{-15}$
Model 4	Involvement	0.22	0.88	160.1	2.93	.01
Model 5	Entrepreneurial course	0.24	0.87	50.8	111.6	$<10^{-15}$
Model 6	Perceptions of learning environment	0.26	0.86	0.0	9.22	$<10^{-10}$

F statistics refer to partial F-tests comparing fit to the model immediately above

Table 4 Parameter estimates for hierarchical models ($n = 3700$)

Construct	Variable	Model 1 Beta (SE)	Model 2 Beta (SE)	Model 3 Beta (SE)	Model 4 Beta (SE)	Model 5 Beta (SE)	Model 6 Beta (SE)
Personality	Extroversion	0.21*** (0.02)	0.20*** (0.02)	0.19*** (0.02)	0.18*** (0.02)	0.17*** (0.02)	0.16*** (0.25)
	Agreeability	−0.12*** (0.02)	−0.08*** (0.02)	−0.07*** (0.02)	−0.07*** (0.02)	−0.06*** (0.02)	−0.07*** (0.02)
	Conscientiousness	0.18*** (0.02)	0.19*** (0.02)	0.19*** (0.02)	0.19*** (0.02)	0.18*** (0.02)	0.16*** (0.02)
	Emotional stability	0.12*** (0.02)	0.10*** (0.02)	0.09*** (0.02)	0.09*** (0.02)	0.09*** (0.02)	0.09*** (0.02)
	Openness to experience	0.11*** (0.02)	0.11*** (0.02)	0.14*** (0.02)	0.14*** (0.02)	0.14*** (0.02)	0.13*** (0.02)
Descriptive	African-American[a]		0.01 (0.07)	0.06 (0.07)	0.05 (0.07)	0.01 (0.07)	0.00 (0.07)
	Asian[a]		0.12* (0.05)	0.09 (0.05)	0.08 (0.05)	0.09 (0.05)	0.11* (0.05)
	Bi/Multi-racial[a]		−0.15 (0.09)	−0.13 (0.09)	−0.12 (0.09)	−0.09 (0.09)	−0.06 (0.09)
	Latin[a]		−0.07 (0.06)	−0.06 (0.06)	−0.06 (0.06)	−0.06 (0.06)	−0.06 (0.06)
	Native American[a]		0.20 (0.13)	0.20 (0.13)	0.19 (0.13)	0.16 (0.13)	0.11 (0.13)
	White[a]		−0.09* (0.04)	−0.07 (0.04)	−0.07 (0.04)	−0.05 (0.04)	−0.03 (0.04)
	Other race[a]		−0.11 (0.08)	−0.07 (0.09)	−0.08 (0.08)	−0.07 (0.08)	−0.07 (0.08)
	Male		0.18*** (0.03)	0.11** (0.03)	0.10** (0.03)	0.09** (0.03)	0.09** (0.03)
	Socioeconomic status (wealthy)		−0.05** (0.02)	−0.03* (0.02)	−0.04** (0.02)	−0.04* (0.02)	−0.04* (0.02)

Table 4 continued

Construct	Variable	Model 1 Beta (SE)	Model 2 Beta (SE)	Model 3 Beta (SE)	Model 4 Beta (SE)	Model 5 Beta (SE)	Model 6 Beta (SE)
	Age		−0.01 (0.02)	−0.01 (0.02)	0.00 (0.02)	0.00 (0.02)	0.00 (0.02)
	Family exposure to entrepreneurship		0.42*** (0.03)	0.38*** (0.03)	0.38*** (0.03)	0.34*** (0.03)	0.32*** (0.03)
Educational/political	High grade point average			−0.08*** (0.02)	−0.09*** (0.02)	−0.08*** (0.02)	−0.09*** (0.02)
	Politically liberal			−0.08*** (0.02)	−0.08*** (0.02)	−0.07*** (0.02)	−0.07*** (0.02)
	Accounting[a]			0.22* (0.09)	0.23* (0.09)	0.23* (0.09)	0.23* (0.09)
	Advertising[a]			0.14* (0.06)	0.13* (0.06)	0.12* (0.06)	0.12* (0.06)
	Banking[a]			0.30** (0.10)	0.30** (0.10)	0.29** (0.10)	0.30** (0.10)
	Computer[a]			−0.01 (0.09)	0.00 (0.09)	0.00 (0.09)	−0.01 (0.09)
	Consulting[a]			0.23* (0.09)	0.22* (0.09)	0.19* (0.09)	0.21* (0.09)
	Education[a]			−0.25*** (0.05)	−0.25*** (0.05)	−0.20*** (0.05)	−0.23*** (0.05)
	Entertainment[a]			−0.10 (0.07)	−0.09 (0.07)	−0.10 (0.07)	−0.07 (0.07)
	Environment[a]			0.03 (0.11)	0.00 (0.11)	0.00 (0.11)	−0.04 (0.11)
	Finance[a]			0.28*** (0.08)	0.28*** (0.08)	0.26*** (0.08)	0.27*** (0.08)
	Government[a]			−0.09 (0.08)	−0.10 (0.08)	−0.05 (0.08)	−0.04 (0.08)

Table 4 continued

Construct	Variable	Model 1 Beta (SE)	Model 2 Beta (SE)	Model 3 Beta (SE)	Model 4 Beta (SE)	Model 5 Beta (SE)	Model 6 Beta (SE)
	Health care[a]			−0.18*** (0.05)	−0.18*** (0.05)	−0.14** (0.05)	−0.15** (0.05)
	Hospitality[a]			0.01 (0.15)	0.00 (0.15)	−0.12 (0.15)	−0.12 (0.15)
	Insurance[a]			−0.29 (0.32)	−0.27 (0.32)	−0.23 (0.31)	−0.20 (0.31)
	Internet[a]			−0.31 (0.21)	−0.30 (0.21)	−0.33 (0.21)	−0.36 (0.21)
	Legal[a]			0.08 (0.07)	0.07 (0.07)	0.11 (0.07)	0.12 (0.07)
	Nonprofit[a]			0.00 (0.07)	0.00 (0.07)	0.03 (0.07)	0.03 (0.07)
	Real estate[a]			0.05 (0.11)	0.07 (0.11)	0.06 (0.11)	0.06 (0.11)
	Retail[a]			0.04 (0.15)	0.02 (0.15)	0.01 (0.15)	0.00 (0.15)
	Other major[a]			−0.14*** (0.04)	−0.14*** (0.04)	−0.13*** (0.04)	−0.13*** (0.04)
Involvement	Participate in fraternity/sorority				0.02 (0.04)	0.02 (0.04)	0.01 (0.04)
	Club/team leadership				0.06 (0.03)	0.06 (0.03)	0.05 (0.03)
	Participate in research				0.07* (0.04)	0.06 (0.03)	0.03 (0.04)
	Resident assistant				−0.01 (0.04)	−0.01 (0.04)	−0.01 (0.04)
	Internship				0.06* (0.03)	0.05 (0.03)	0.03 (0.03)

Table 4 continued

Construct	Variable	Model 1 Beta (SE)	Model 2 Beta (SE)	Model 3 Beta (SE)	Model 4 Beta (SE)	Model 5 Beta (SE)	Model 6 Beta (SE)
Entrepreneurial class	Enroll in entrepreneurial class					0.39*** (0.04)	0.36*** (0.04)
Perceptions of learning environment	Challenging learning environments						0.02 (0.02)
	Connecting experiences						0.04* (0.02)
	Assessments encouraging argument development						0.04* (0.02)
	Assessments encouraging innovative approaches to problem–solving						0.09*** (0.02)
	Personal relationships with faculty						0.05** (0.02)
	Time students spend on academic work						0.03 (0.02)
	Academic work pushes out of comfort zone						−0.03* (0.02)

[a] Effect coding; omitted category irrelevant

* $p < .05$, ** $p < .01$, *** $p < .001$

($\beta = .211$, $p < .001$). In addition, students who were more emotionally stable were more likely to intend to innovate than those less emotionally stable ($\beta = .123$, $p < .001$). Also, students who were more conscientious were significantly more likely than those less conscientious to intend to innovate ($\beta = .182$, $p < .001$). Moreover, students who were more open to new experiences were significantly more likely to express intentions to innovate than those less open to new experiences ($\beta = .110$, $p < .001$). Finally, students who were less agreeable were significantly more likely to intend to innovate than those who were more agreeable ($\beta = -.108$, $p < .001$). Although effect magnitudes varied slightly across model iterations, the direction of these effects remained consistent across model iterations.

Adding descriptive information to the model (Model 2) explained an additional and significant 5.3% of variance in the criterion. With regard to self-identified race, compared with all students, those self-identifying as Asian were significantly more likely to express an intention to innovate ($\beta = .121$, $p < .05$). Males were also significantly more likely than females to express an intention to innovate ($\beta = .175$, $p < .001$). These effects hold through most model iterations, including Model 6, the final model. In addition, in Model 2, white students were significantly less likely to intend to innovate ($\beta = -.084$, $p < .05$) compared to all other students, although this effect falls out of significance in future model iterations. Turning to socioeconomic status, wealthier students were significantly less likely to intend to innovate than students from lower socioeconomic backgrounds ($\beta = -.046$, $p < .01$); this effect holds constant but decreases slightly in magnitude across model iterations. Finally, students with more family exposure to entrepreneurship were significantly more likely to intend to innovate than those with less exposure ($\beta = .416$, $p < .001$); this effect holds through model iterations.

Comprised of educational and political covariates, Model 3 explained a significant and additional 3.2% of variance in the criterion. Turning to self-reported grade point averages, those with higher grade point averages were significantly less likely to express an intention to innovate than those with lower grade point averages ($\beta = -.075$, $p < .001$); this effect holds through model iterations. Also, students who were more conservative politically were also significantly more likely to express innovation intentions than politically liberal students ($\beta = -.081$, $p < .001$); again this effect holds across model iterations. Turning to major, when compared to effects reported for all students, accounting majors ($\beta = .224$, $p < .05$), banking majors ($\beta = .304$, $p < .01$), finance majors ($\beta = .275$, $p < .001$), consulting majors ($\beta = .227$, $p < .05$) and advertising majors ($\beta = .135$, $p < .05$) were significantly more likely to express innovation intentions, while education majors ($\beta = -.253$, $p < .001$), health-related majors ($\beta = -.176$, $p < .001$), and "other" majors ($\beta = -.144$, $p < .001$) were significantly less likely than all other students to express innovation intentions. All of the aforementioned effects for major held across model iterations.

Involvement covariates comprising Model 4 contributed a significant additional .2% of variance in the criterion. Although effects were noted for students participating in research ($\beta = .073$, $p < .05$) and those participating in internship experiences ($\beta = .062$, $p < .05$), these effects fell out of significance in Models 5 and 6.

Model 5 included only one covariate: taking an entrepreneurship class. Adding this variable contributed a significant and additional 2.3% of the variance in the criterion. Constant across model iterations, students who enrolled in an entrepreneurship class were significantly more likely to express an intention to innovate than those who did not enroll in such a class ($\beta = .389$, $p < .001$).

The full model, Model 6, included covariates measuring educational practices. Adding this block of variables contributed a significant and additional 1.2% of variance in the

criterion. Of greatest interest to educators, of course, is that four of the faculty practice constructed variables were significantly associated with intent to innovate, although their effect sizes were not as large as those of several demographic variables. Interestingly, the largest effect did not correspond to a direct teaching activity, but rather to assessments of learning, with a positive association of intention to innovate with assessments that encouraged students to take innovative approaches to problem-solving ($\beta = .092$, $p < .001$). Similarly, another significant practice effect corresponds to a positive association with assessments that encouraged students to develop arguments ($\beta = .035, p < .05$). Thus, while teachers can use a pedagogical style that challenges students and encourages them to think critically, it appears to be examinations and graded assignments that engage students enough to be associated with internal motivation to become innovative.

In addition to these assessment variables, two other characteristics of faculty practice appear to be important. First, as has been noted in other contexts (see Pascarella et al. 2005), students responded well to the perception of having more personal relationships with faculty ($\beta = .048$, $p < .01$). Second, a practical orientation of coursework was important to encourage the intention to innovate, as the perception that coursework was connected to outside societal issues is positively associated with it, holding all else fixed ($\beta = .037, p < .05$). It seems natural to suppose that this could be related to the fact that innovative entrepreneurial ventures could very well be aimed at directly addressing gaps in society's ability to solve important issues. Finally, it appeared as though being pushed out comfort zones had a negative relationship with intention to innovate ($\beta = -.033, p < .05$).

Model Verification Analyses

In order to address the violations of assumptions seen in the least squares regressions, the four underlying ordinal categorical variables (how effective the respondent feels they are at identifying new business-related opportunities; how effective they feel they are at acquiring the resources necessary to take advantage of a new business opportunity; how effective they feel they are at developing a strategy to take advantage of a new business-related opportunity; and how effective they feel they are at developing a new entity to take advantage of a new business-related opportunity, respectively) that were summed (and then standardized) to produce the intention to innovate variable were analyzed separately using proportional odds models (Simonoff 2003). By doing this, violation of the usual least squares regression assumptions was no longer relevant. In addition, these models made it possible to uncover subtleties in the earlier patterns, since it was now possible to examine how the different covariates relate (or do not relate) to specific aspects of the intention to innovate.

In order to validate our outcome measure comprised of ordinal data, Table 5 presents the signs of the coefficients of the significant predictors from the least squares model for intention to innovate that were also statistically significant in the various proportional odds models. Notably, each statistically significant coefficient has the same sign in each of the proportional odds fits as it did in the least squares model; thus, the violations of assumptions in that model have not affected the implications of the results. Next, it is apparent that several of the variables were broadly associated with intention to innovate, since they were significantly associated with all four ordinal responses. These included all five personality variables; family exposure to entrepreneurship; grade point average; political views; having enrolled in an entrepreneurial class; and the faculty practice variable corresponding to assessments requiring students to propose innovative solutions to new problems. Thus, it seems that basic underlying characteristics of a student and

Table 5 Signs of coefficients of significant predictors from least squares model in proportional odds models for underlying components of intention to innovate variable

		Identifying opportunities	Acquiring resources	Developing a strategy	Developing a new entity
Personality	Extroversion	+	+	+	+
	Agreeability	–	–	–	–
	Conscientiousness	+	+	+	+
	Emotional stability	+	+	+	+
	Openness to experience	+	+	+	+
Descriptive	Asian		+	+	+
	Male	+			
	Socioeconomic status (wealthy)			–	–
	Family exposure to entrepreneurship	+	+	+	+
Educational/ Political	Grade point average	–	–	–	–
	Political views (liberal)	–	–	–	–
	Accounting major		+	+	
	Advertising major	+			
	Banking major		+	+	+
	Consulting major			+	
	Education major	–	–	–	–
	Finance major		+	+	+
	Health care major	–	–	–	
	"Other" major	–	–	–	
Entrepreneurial Class	Enroll in entrepreneurial class	+	+	+	+
Perceptions of learning environment	Connecting experiences		+		+
	Assessments encouraging argument development		+		+
	Innovative classroom practices	+	+	+	+
	Personal relationships with faculty		+	+	+
	Being pushed out of academic comfort zone			–	

exposure to entrepreneurship are important in encouraging a broad interest in innovative entrepreneurship—as is the use of assessments requiring innovative solutions.

Figure 1 summarizes results validating our model's consistency across universities. Each plot in the figure is a set of two kernel density estimates (Simonoff 1996): the first gives the errors obtained when predicting the intention to innovate response in that university using a model based only on students from all of the other universities (solid line), and the second gives the residuals from the model, fit to all students from that university (dashed line). Smoothness of the density estimates is controlled using the smoothing parameter selector of

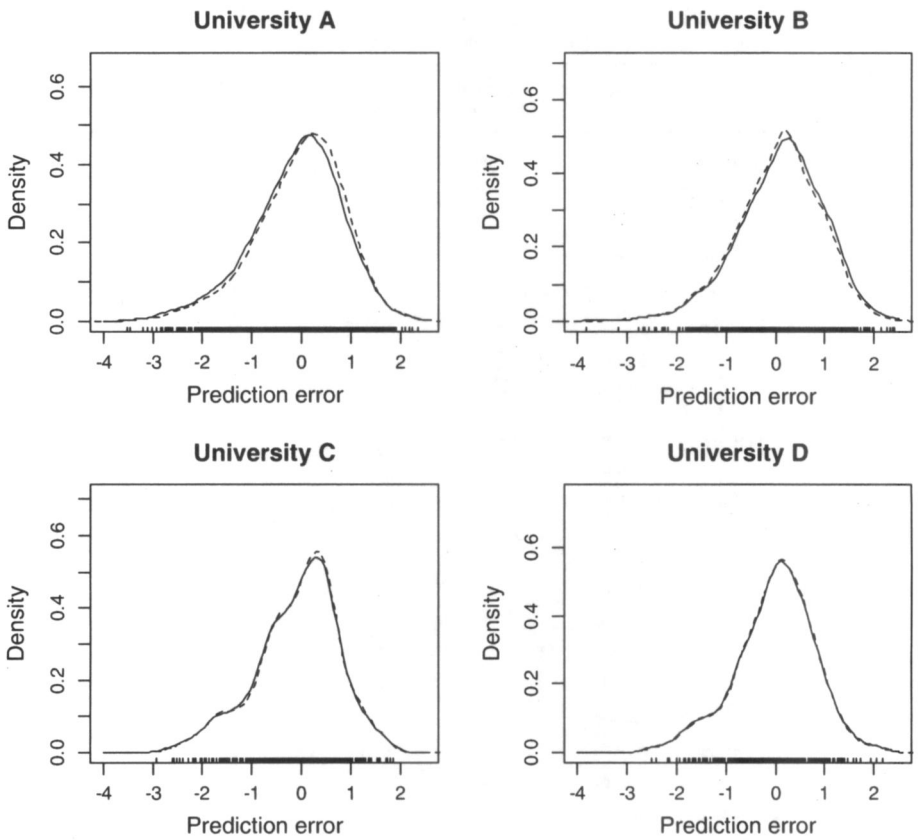

Fig. 1 Estimated densities of residuals (*dashed line*) and cross-validated predictive errors (*solid line*) for students from each of four universities

Sheather and Jones (1991). Plots are given for only four of the universities because the sample size from the fifth is too small to construct a meaningful density estimate.

The plots indicate that distributions of the residuals and predictive errors in each university were very similar to each other. This implies that it is reasonable to expect that the results found here using all of the data would carry over to application at other universities. Since the universities examined here cover a wide range of types (University A is a very large state university, University B is a large private university, University C is a large state university, and University D is a small private university), the success of this validation provides robust support for the external validity of the model.

Finally, we also explored potential differences between universities by refitting the models, now including university as a random effect in a linear mixed model (Goldstein 2011). We found that including university only changed the regression coefficients very slightly, and did not affect any of the implications of the results previously discussed.

Discussion

There is much evidence to indicate that the innovative entrepreneurs who focus on the introduction and acceptance of new products and new production methods have made

indispensible contributions to the industrial revolution and the ensuing period of unparalleled economic growth. Already, such growth has done much to contain the poverty that arguably has been the blight of human society. But, evidently, the task is far from finished, and, thus, innovative entrepreneurs surely will continue to play a vital role in the sequel to that earlier growth. Learning how to train these entrepreneurs more effectively is a vital step in this process, and it is to this purpose that the study reported here has been dedicated.

Increasing national sociopolitical and economic challenges have inspired colleges and universities to extend dimensions of teaching and learning to practices that inspire students to become more innovative. This study takes a small but important step towards this end, in seeking to understand the educational practices that influence students' innovative entrepreneurship intentions.

Dominating scholarly discussions focused on innovative entrepreneurship are lingering questions concerning its ontology: Is innovation something that can be nurtured in college? Results from this study suggest that it can. After controlling for a host of covariates, including dimensions of personality, family history with entrepreneurship, student entry characteristics, and involvement experiences, it appears that enrolling in an entrepreneurship course *and* the practices faculty enact within courses are related to students' intentions of becoming innovative entrepreneurs.

Our findings indicate that specific practices that can influence innovation intentions include assessments that encourage innovative approaches to problem-solving and evaluate students' abilities to construct and defend an argument. Apparently, instilling the desire to innovate within this sample of students is at least partially a function of communicating its value and importance via assessment strategies. Should faculty be interested in facilitating students' innovation intentions, it is critical for these educators to problematize antiquated notions of assessment as a necessary but unwelcome element of practice and to reframe assessment as an effective pedagogical tool, inspiring students to create, construct, and defend innovative solutions to presented social problems. This study provides one piece of evidence supporting what assessment champions have been touting for decades; as Banta et al. (1996) note,

> Effective assessment programs reflect the imaginative, creative, and energizing aspects of learning, not only so as to more accurately measure the breadth and depth of the learning experiences but also to contribute to the ongoing spirit of inquiry, reflection, and growth that characterize the university as an institution (p. 11).

Co-curricular practices also inspire students to intend to innovate. The dominant theme across two factors shown to relate to innovation intentions involved out-of-classroom experiences, both in general and in association with personal relationships with faculty members. These findings resonate with those from previous college impact studies (see Pascarella and Terenzini 2005), urging educators to approach their roles more holistically. Administrators may want to consider a paradigmatic shift in their approach to understanding faculty work and encourage their faculty to interact with students outside of the classroom. Some institutions exemplify this shift, as encouragement has taken the form of faculty-in-residence programs, faculty affiliate programs, and faculty-led study abroad trips.

The one practice that negatively related to innovation intentions involved assigning academic work that pushed students out of their comfort zone. What does comfort zone mean to students? Evidence from this study would suggest that students have different conceptions underlying the idea of "comfort zones," as this item remained a single-item indicator after failing to converge with other potentially-related items. Perhaps these

students have expanded comfort thresholds with regard to anything innovative. This is a hallmark of students of this generation who often are characterized as "millennials" (see Grossman 2005). Future research is needed to unpack the seemingly nuanced relationship between comfort and innovation and how the relationship might inform the educational practices enacted in the classroom.

Of all included variables, participation in an entrepreneurial course had the greatest effect on students' innovation intentions, regardless of relevant covariates such as college major, grade point average, and family history of entrepreneurship. As a symbolic reflection of an institution's priorities (Stark and Lattuca 1997), course-taking matters. Institutions that seek to spur innovation among their students may want to offer courses in entrepreneurship not only to students majoring in business-related fields but to all students, as suggested by authors of previous studies (Kauffman Panel on Entrepreneurship Curriculum in Higher Education 2008; Katz 2003; Kuratko 2005; Levenburg et al. 2006).

Student exposure to a history of family involvement with entrepreneurial ventures also was related to students' innovation intentions. It appears as though modeling an entrepreneurial spirit at an early age has an effect on students' innovation intentions at the time of graduation with a baccalaureate degree. What remains encouraging, if not remarkable, is that intentions to innovate can still be nurtured beyond socializing family experiences and innate personality traits. An interesting outgrowth from this study might involve longitudinally tracking students' intentions to innovate based on family exposure to entrepreneurship: Might there be different innovation trajectories for students from families with histories of entrepreneurship versus students without such histories? Questions, like that represented here, provide fruitful opportunities for future research.

Turning to other descriptive, educational, and political variables, some results were more surprising than others. In terms of race and ethnicity, students identifying as Asian or Asian-American were significantly more likely than all other students to express intentions to innovate. Although the link between self-identified race and innovative entrepreneurship has yet to be the focus of scholarly inquiry, recent work shows that individuals identifying as Asian have a higher probability of business ownership than other minority groups given other demographic characteristics (see Fairlie 2008). More specifically, Fairlie (2008) has indicated that individuals identifying as Korean have the highest rate of business formation among immigrants (per capita), and have a high business ownership rate, especially when compared to Asian individuals from other ethnic backgrounds. Although the specific link between race and ethnicity and innovative entrepreneurship remains an area for future inquiry, these results, framed within the context of Fairlie's work (2008), demonstrate the importance of designing research that accounts for the specific racial and ethnic identity patterns of individuals, especially in the case of Asian students. Failure to do so may lead to stereotyping based on socially-constructed myths associated with a particular racial or ethnic group (see Teranishi 2010).

Of particular surprise was the finding that students from lower socioeconomic backgrounds were significantly more likely to express intentions to innovate than students from wealthier backgrounds. Given the dearth of empirical studies designed to examine intentions to innovate, we can only speculate that students self-identifying in these ways hold cultural assumptions about the importance of innovation that other students do not. The fact that these students, who hold minority positions when compared to the majority of college-going students, have successfully matriculated in a college system designed to maintain the privileges of the white, rich class (see Giroux and Giroux 2004) may reflect some form of innovation: Certainly it takes creativity to navigate the hegemonic admissions practices of most elite schools.

Equally interesting was the finding suggesting that students with lower grade point averages also were more likely to have innovation intentions than students with higher grade point averages. Perhaps students with propensities toward innovation are less concerned with grading systems that rely on memorization by way of assessment than students with higher grade point averages. Alternatively, college-going students with innovation intentions may be more likely to approach their education as a means to discover new ideas, wanting more out of the experience than a series of external valuations in the form of grade point averages. It is also possible that a lower grade point averages signals to students that they are unlikely to do well in established bureaucratic structures; students may have higher intentions to become innovative entrepreneurs because they do not perceive that they will be successful in a more established route. Future research is needed to examine these relationships in light of this study's findings.

Perhaps more intuitive were the results relating college major to innovation intentions. When compared to effects reported for all students, majors related to business, such as finance, consulting, and advertising, were significantly more likely to express innovation intentions. Alternatively, majors associated with education and health were significantly less likely than all other majors to express innovation intentions. Interestingly, many health professionals such as doctors, are small business owners and therefore entrepreneurs, but perhaps they are not innovative entrepreneurs. This may indicate that the measure of innovative entrepreneurial intentions indeed captures innovative rather than replicative entrepreneurship, or perhaps the new generation of potential physicians views changes in health care as removing entrepreneurship from the equation. In either case, assuming that intention to innovate should be considered as an outcome for consideration for all students, institutions may need to consider expanding the traditional reach of entrepreneurial coursework and out-of-classroom experiences to students across majors. Such an expansion may incite the interdisciplinary thinking needed to successfully grapple with the many challenges facing the twenty-first century.

Implications

This study's implications for higher education scholars and practitioners are far-reaching. First, stakeholders within accreditation and higher education associations may be challenged to rethink learning as something more than content mastery or even critical thinking. Expanding the traditional understanding of learning may, ironically, be the type of innovation needed to equip students with the knowledge and skills to address the increasingly complex issues facing the next century.

Second, institutions may want to challenge views of learning that suggest that certain content, like entrepreneurship, should be discipline-specific, housed mainly in schools of business. Findings from this study indicate that intention to innovate can be achieved by students across disciplines. Certainly, the innovation required to face the challenges of the next century will require collaboration among disciplinary perspectives and paradigmatic approaches to inquiry.

Third, educational practices matter. That faculty have a role in designing educational opportunities that inspire students to want to innovate is critical, answering theoretical challenges implying that inclinations toward innovative entrepreneurship are only a function of personality. Specifically, faculty should use assessments designed to inspire students to create, construct, and defend innovative solutions to presented social problems.

These faculty members should not avoid rote learning altogether but, rather, should stress the quest for new methods and new results.

Conclusion

There can be no doubt that, in the long run, nothing matters more for the economic welfare of any nation than the preservation and effective utilization of the historically unprecedented flood of innovations from which many economies have benefitted during the past two centuries. This phenomenon has brought with it a rise in overall living standards that no other time or place has been able to approximate. Indeed, the most conservative estimates conclude that, in the last century, per capita incomes in the United States and a number of other countries increased by an incredible 600 percent, in the process materially enhancing longevity, reducing poverty, and raising general living standards incalculably.

Innovative entrepreneurs (i.e., the individuals who recognize, draw attention to, and ensure effective utilization of novel products and ideas) have played a vital role in this incredible economic growth. History is replete with examples of societies with remarkable records of invention but comparatively unimpressive economic growth. Without effective incentives for innovative entrepreneurs, who devote themselves to the task of producing and marketing new inventions, these societies were unable to reap the economic rewards of their inventiveness (see Drucker 1993). The innovative entrepreneur, then, is one of the gears in the engine that drives economic progress; without this wheel, as in a mechanical watch, the entire growth mechanism is brought to a halt.

As educators, it is our responsibility to examine innovative entrepreneurship and its related educational practices and experiences, especially in the context of challenging economic times. This study serves as an initial step towards this end.

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