

Entrepreneurship Education for Professional Formation

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NEED

The professional context for the future engineer is changing. Engineering graduates can no longer expect a career with a single employer and they must be prepared to meet the needs of diverse organizations. Companies are looking for engineers who can identify unmet needs, problem solve under time constraints, and adapt to technological change. In response to changing career needs, higher education institutions are reforming how they train engineers. Most recently, this reform has led to the incorporation of entrepreneurship into engineering undergraduate curriculum.

As more programs rush to launch engineering entrepreneurship programs, it is critical that we better understand the outcomes of entrepreneurship education (EE) as a function of cognition, affect and behavior and how it supports the professional formation of future engineers. The recent introduction and adaptation of the NSF Lean Launch (LL) curriculum enables a powerful platform through which the purpose and value of EE in engineering can be evaluated.

GOALS

This project investigates how EE is bridging the gap between traditional education and the career needs of the 21st century engineer by:

1. **Establishing the fundamental concepts engineering students can gain from entrepreneurship education;**
2. **Generating outcome measures aligned with the goals of EE for engineers;**
3. **Conducting pilot evaluation of how we are teaching engineering students 21st century skills through the emerging LL entrepreneurship curriculum; and**
4. **Developing assessment material that can be used by engineering faculty, staff and administrators launching engineering entrepreneurship programs.**

STUDY 1: SYSTEMATIC LITERATURE REVIEW

- The research team finalized a major, systematic literature review of entrepreneurship education research in business, engineering, psychology and higher education to identify major themes and theoretical constructs being pursued in entrepreneurship education.
- The search yielded 2,841 unique papers. Once inclusion and exclusion criteria were applied, 476 papers were coded for study design, theory, variables measured, instruments, and validity and reliability.

CHARACTERISTICS	ENTREPRENEURSHIP ASSESSMENT STUDIES (N=476)	ENGINEERING SPECIFIC STUDIES (N=27)
TYPE OF STUDY		
Intervention	132 (28%)	13 (48%)
Characterization	344 (72%)	14 (52%)
SUBJECTS		
Undergraduates	270 (57%)	21 (78%)
Graduate Students	84 (18%)	1 (4%)
Undergraduate Alumni	19 (4%)	2 (7%)
Graduate Alumni	10 (2%)	---
Faculty	40 (8%)	4 (15%)
Entrepreneurs	133 (28%)	4 (15%)
DISCIPLINES		
Business	271 (57%)	8 (30%)
Engineering	75 (16%)	22 (81%)
Multidisciplinary	166 (35%)	5 (19%)
BASIC MEASURES		
Age	281 (59%)	12 (44%)
Gender	335 (70%)	13 (48%)
Ethnicity/Race	55 (12%)	5 (19%)
Parent's Education	9 (2%)	2 (7%)
THEORIES/PROTOCOLS/MEASURES		
Theoretical Framework	50 (11%)	1 (4%)
Referenced Theory	238 (50%)	6 (22%)
Qualitative Methods	110 (23%)	9 (33%)
Quantitative Methods	403 (85%)	20 (74%)
Use of Existing Scale	263 (55%)	10 (37%)
Attempted Validity/Reliability Testing	311 (65%)	11 (41%)

VARIABLE TYPE	EXAMPLE OR DETAILS	FREQUENCY
AFFECTIVE VARIABLES (n=393)		
Perceptions	Perceptions of new venture opportunities	142 (36%)
Attitude	Entrepreneurial attitude	101 (26%)
Self-efficacy/Self-esteem	Entrepreneurial self-efficacy	71 (18%)
Entrepreneurial Orientation	Includes proactiveness, risk-taking	64 (16%)
Motivation	Motivation to open a business	46 (12%)
Creativity	Creativity, creation process	42 (11%)
Beliefs	Behavioral beliefs, locus of control	31 (8%)
Entrepreneurial Mindset	State of mind – innovation/creation/opportunity	17 (4%)
BEHAVIORAL VARIABLES (n=286)		
Entrepreneurial intentions	Future plans to engage in entrepreneurial activity	113 (40%)
Behaviors	Entrepreneurial activities	57 (20%)
Work Experience	Generic work experience	33 (12%)
Plans/Goals	Entrepreneurial career aspirations	27 (9%)
COGNITIVE MEASURES (n=72)		
Skills	Business competencies	32 (44%)
Knowledge	Financial literacy	15 (21%)
Communication	Speaking skills	5 (7%)

- Results showed little cross-fertilization across disciplines. Empirical studies are in the minority and the majority focus on affective, rather than cognitive or behavioral, outcomes.

STUDY 2: ASSESSMENT OF LEARNING OUTCOMES

The team has also launched a preliminary survey that measures self-efficacy, behavior and knowledge in students enrolled in several different LL classes/programs across the university. The survey instruments used are based on published, validated surveys. Initial results using the McGee et al. (2009) validated entrepreneurial self-efficacy survey are presented here.

- 3 engineering sponsored entrepreneurship capstone course students were surveyed at the beginning and end of the semester.
- 108 students completed the pre-survey, 89 students completed the post-survey
- Simple confirmatory factor analysis for each scale on pre-test data to confirm that scales from McGee et al 2009 are effective in this population.
- Pre/post paired sample T-tests indicated that for n=44 matched tests, all scores, except for Attitude were higher on Post-test than on Pre-test. Search (t=2.47, p=0.17) and Planning (t=3.11, p=.003) scores are statistically different across the two implementations. Calculation of effect size as Cohen's d based on sample means indicates medium effect size.

BROADER IMPACTS

As the rate of technology change continues to increase and the nation's economic future becomes increasingly dependent on innovation, engineering schools must adapt to the needs of the new economy. By understanding how students learn to be entrepreneurially minded, we can affect how we are not only training future engineers, but also those in the sciences and liberal arts. The results of this proposal will offer faculty and administration a better understanding of core skills and learning outcomes that can be expected from the curriculum and preliminary data on the effect of the pedagogy on cognitive learning.

PROJECT PUBLICATIONS

Huang-Saad, A.Y, Morton, C., Libarkin, J.C., "Entrepreneurship in Higher Education: A Research Review for Engineering Education." Submitted 3/18/16.

Morton, C., Huang-Saad, A.Y., Libarkin, J.C., "Entrepreneurship Education for Women in Engineering: A Systematic Review of Entrepreneurship Assessment Literature with a Focus on Gender." 2016 ASEE Annual Conference

Huang-Saad, A.Y., Morton, C., Libarkin, J.C., "Unpacking the Impact of Engineering Entrepreneurship Education that Leverages the Lean Launch Curriculum." 2016 Frontiers in Education Conference (In preparation).

CITATIONS: McGee, J.E., Peterson, M., Mueller, S.L., and Sequeira, J.M., "Entrepreneurial Self-Efficacy: Refining the Measure." *Entrepreneurial Theory & Practice*, July 2009.

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