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Development of an Instrument to Measure the Entrepreneurial Mindset of Engineering Students

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Development of an Instrument to Measure the Entrepreneurial Mindset of Engineering Students

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Cheryl Qing Li joined University of New Haven in the fall of 2011, where she is a Senior Lecturer of the Industrial, System & Multidisciplinary Engineering Department. Li earned her first Ph.D. in mechanical engineering from National University of Singapore in 1997. She served as Assistant Professor and subsequently Associate Professor in mechatronics engineering at University of Adelaide, Australia, and Nanyang Technological University, Singapore, respectively. In 2006, she resigned from her faculty job and came to Connecticut for family reunion. Throughout her academic career in Australia and Singapore, she had developed a very strong interest in learning psychology and educational measurement. She then opted for a second Ph.D. in educational psychology, specialized in measurement, evaluation and assessment at University of Connecticut. She earned her second Ph.D. in 2010. Li has a unique cross-disciplinary educational and research background in mechatronics engineering, specialized in control and robotics, and educational psychology, specialized in statistical analysis and program evaluation.

Dr. Ronald S. Harichandran, University of New Haven

Ron Harichandran is Dean of the Tagliatela College of Engineering and is the PI of the grant entitled Developing Entrepreneurial Thinking in Engineering Students by Utilizing Integrated Online Modules and a Leadership Cohort. Through this grant entrepreneurial thinking will be integrated into courses spanning all four years in seven ABET accredited engineering and computer science BS programs.

Dr. Maria-Isabel Carnasciali, University of New Haven

Maria-Isabel Carnasciali is an Assistant Professor of Mechanical Engineering at the Tagliatela College of Engineering, University of New Haven, CT. She obtained her Ph.D. in Mechanical Engineering from Georgia Tech in 2008. She received her Bachelors of Engineering from MIT in 2000. Her research focuses on the nontraditional engineering student – understanding their motivations, identity development, and impact of prior engineering-related experiences. Her work dwells into learning in informal settings such as summer camps, military experiences, and extra-curricular activities. Other research interests involve validation of CFD models for aerospace applications as well as optimizing efficiency of thermal-fluid systems.

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Jean Nocito-Gobel, Professor of Civil & Environmental Engineering at the University of New Haven, received her Ph.D. from the University of Massachusetts, Amherst. She has been actively involved in a number of educational initiatives in the Tagliatela College of Engineering including KEEN and PITCH, PI of the ASPIRE grant, and is the coordinator for the first-year Intro to Engineering course. Her professional interests include modeling the transport and fate of contaminants in groundwater and surface water systems, as well as engineering education reform.

Development of an Instrument to Measure the Entrepreneurial Mindset of Engineering Students

Abstract

This work in progress describes the development of an instrument to measure the entrepreneurial mindset of engineering students.

The need for developing an entrepreneurial mindset in engineering students is being recognized by many universities. However, very few comprehensive, generalized and well-validated instruments are available for assessment purpose. Most research and educational efforts focus on the design and implementation of engineering entrepreneurship programs, but assessment practices have not kept up. There are several reasons for the shortfall in assessment practices: 1) Introducing engineering students to entrepreneurship is a relatively new trend and it will take time for the successes to be quantified and assessed; 2) There are inconsistencies across different engineering entrepreneurship programs; 3) The program can involve a single course, multiple courses, projects or experiential learning; 4) The concepts can be taught by engineering faculty, business faculty, practicing engineers, or a mix of these. These program differences lead to variations in assessment methods and instruments. Most importantly, there is lack of a clear, consistent and comprehensive definition of engineering entrepreneurship characteristics within the community.

Based on the framework established by the Kern Entrepreneurial Engineering Network (KEEN), this paper describes the development of an assessment instrument to measure the entrepreneurial mindset of engineering students. An assessment instrument consisting of 37 questions was initially developed. An exploratory factor analysis of this pilot instrument resulted in a 29-item solution. Additional reliability analysis based on Cronbach's α suggested further reduction of items with low internal consistency. Finally, a preliminary instrument with 27 items loaded on 9 or 10 factors measuring the entrepreneurial mindset was established.

Introduction

The need for engineering entrepreneurship education has been well reported in the past two decades. However, very few comprehensive, generalized and well-validated assessment instruments are available for use by engineering entrepreneurship programs. Most research and educational efforts focus on the design and implementation of engineering entrepreneurship programs. There is a gap in assessment practices[1-2] and there are several reasons for this. Since introducing engineering students to entrepreneurship is a relatively new trend, it will take a long time to fully implement engineering entrepreneurship programs and assess them. There are also inconsistencies across different engineering entrepreneurship programs and they can involve a single course, multiple courses, projects or experiential learning, a concentration, a minor or a major. They can also be taught by engineering faculty, business faculty, practicing engineers, or a mix of different members.[3] These program differences lead to variations in assessment methods and instruments. Most importantly, there is also a lack of a clear, consistent and comprehensive definition of engineering entrepreneurial characteristics in the community.[4] It is not clear if engineering entrepreneurship should be different from entrepreneurship in general, or if engineering entrepreneurial characteristics are a set of entrepreneurial related behaviors, personal traits and attitudes, or a specialized set of engineering skills.

Sponsored by the Kern Family Foundation, the Kern Entrepreneurial Engineering Network (KEEN) calls for "a collaboration of U.S. universities that strive to instill an entrepreneurial mindset in undergraduate engineering and technology students."[5] KEEN's mission is "to graduate engineers with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work."[5] KEEN states that an entrepreneurially minded engineer should possess *curiosity* about our changing world, habitually make *connections*, gaining insight from many sources of information, and focus on *creating* value for others.[5] Based on the primary 3C's (italicized in the previous sentence), KEEN has further defined 12 secondary learning outcomes to characterize an entrepreneurial mindset.

Funded by a KEEN grant, we are designing a rigorously validated assessment instrument for measuring the engineering entrepreneurial mindset based on the KEEN framework. We hope eventually that not only the universities within the KEEN network, but also that the engineering entrepreneurial educational field at large will benefit from this instrument.

Instrument Design Methodology

This section describes the development of the assessment instrument to measure the entrepreneurial mindset of engineering students. Purzer et al. performed a comprehensive review of current assessment studies in engineering entrepreneurial education.[6] They found that surveys were the most common method of assessment but there was a lack of well-validated instruments. Most of the available instruments focused on skills assessment and very few studied the mindset toward engineering entrepreneurship. Recently Fernandez et. al. developed an assessment instrument measuring freshman attitudes toward entrepreneurship based on attitude theory.[7] However, an effective assessment instrument that can measure student mindset towards engineering entrepreneurship is yet to be developed. Based on KEEN's framework, we developed an assessment instrument adopting a closed-survey form. Before data collection and exploratory data analysis, the instrument was first validated. Since psychological measurement theory suggests that lengthy questionnaires can lead to low response rates and distorted responses due to fatigue, the survey was designed to be reasonably concise. Students' general entrepreneurial characteristics such as their intellectual and curiosity levels, interests and experiences in entrepreneurship, career plans, etc., were measured through 12 items. The other 25 items were designed to measure the KEEN secondary learning outcomes, with one or two questions related to each outcome.

Questionnaire Generation

Two broad sets of items were generated in this survey questionnaire, with one set designed to measure the general entrepreneurial characteristics, and the other designed to measure the learning outcomes defined by KEEN. A literature review on engineering entrepreneurship assessment indicates that strong interests, high curiosity level, personal experiences and family influences are the main facts that shape a student's general entrepreneurial characteristics.[8] The first set of items was therefore developed to measure these characteristics. KEEN has defined 12 secondary entrepreneurial behaviors as the learning outcomes grouped into the following four categories:

- Engineering Thought and Action:
  Apply creative thinking to ambiguous problems
  Apply systems thinking to complex problems
  Evaluate technical feasibility and economic drivers
  Examine societal and individual needs
- Collaboration:
  Form and work in teams
  Understand the motivations and perspectives of others
- Communication:
  Convey engineering solutions in economic terms
  Substantiate claims with data and facts
- Character:
  Identify personal passions and a plan for professional development
  Fulfill commitments in a timely manner
  Discern and pursue ethical practices
  Contribute to society as an active citizen

The second set of items in the questionnaire was designed to measure the above learning outcomes. To keep the questionnaire short, only one or two questions were developed for each outcome. Note that the terms survey items and survey questions are used interchangeably in the literature and the same is true in this paper.

Item Content Validation

The second step in the development of the assessment instrument was item content validation. Five engineering professors and a one program director from KEEN formed the validation team. A content-validity rating form, which included "Sureness" and "Relevance" as the validation results, was distributed to the validation team. As Netemeyer, et. al. suggested,[9] "Sureness" indicates the validation team's certainty about their judgements using a three level scale: 1 = not very sure, 2 = pretty sure, and 3 = very sure, and "Relevance" reflected how well they thought an item measured what was intended to be measured, using the following scale: 1 = low/no relevance, 2 = somewhat relevant, 3 = highly relevant. Netemeyer, et. al.[9] also recommended retaining items with sureness and relevance levels higher than the means. The items included in the questionnaire have Sureness > 2.17, which means the judges were quite sure about their judgments, and Relevance > 66%, which means more than 66% of the judges rated this item as relevant to what was intended to be measured. After the content validation process, all 37 items were retained in the questionnaire, with 12 items measuring the general entrepreneurial characteristics and 25 measuring the secondary entrepreneurial learning outcomes defined by KEEN. The questionnaire is shown in Appendix A. The items were formatted based on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). In order to avoid biased answers if a student did not understand questions, an addition choice "I don't understand" was given in the questionnaire.

Data Collection

Engineering freshman students from the University of New Haven participated in the study in fall 2014 and fall 2015. Of the 227 valid responses received, the distribution of majors was as follows: 9% computer science/information technology, 3% system engineering, 16% civil engineering, 1% general engineering, 17% electrical/computer engineering, 23% mechanical engineering, 12% chemical engineering/chemistry and 17% undecided. Of all students responding, 12% were international, one or both parents of 72% had received college degrees, and 16% were female. Data was collected during the freshman orientation before the semester started. The survey was administered through Campus Labs, an online assessment tool.

Exploratory Factor Analysis (EFA)

During the initial stage of development of the entrepreneurial mindset assessment instrument, we designed items based on a literature review and KEEN framework. However, we had limited knowledge of the dimensionality of constructs; i.e., we were not sure which items loaded into which factors. EFA was conducted to gain insights as to the potential dimensionality of items.

Method

The most commonly used extraction methods for exploratory factor analysis are principal components analysis (PCA) and common factor analysis, i.e., principal axis factoring (PAF).[10,11] These two methods are mathematically very similar. However, PCA identifies similar groups of variables, whereas PAF identifies the latent constructs behind the observations.[12] In general, PCA is preferred when using factor analysis in causal modeling, and PAF is more suitable when using factor analysis to reduce data.[13] Since we were interested in the dimensions behind the variables, in other words, we wanted to know which items load on what factors, we used PAF as the extraction method.

We needed to choose a rotational method from two rotation options, namely orthogonal rotation and oblique rotation. Normally orthogonal rotation is used for factor structures that are uncorrelated.[14] However, we believed that the variables in our design might be related to more than one factor, and hence used oblique rotation. In research involving human behaviors and opinions, it is general suggested that this method produces more accurate results and the solution is more parsimonious.[11]

The aim of EFA is to reduce a large number of items into factors. Several criteria are available to determine factor extraction, including Kaiser's criteria (eigenvalue >1),[15] percent of variance extracted,[11] and Scree test plot,[11] and multiple approaches should be used. After running EFA using SPSS using the collected data, all these approaches suggested a 12-factor solution. So this solution was naturally adopted as the factor extraction result for further interpretation.

Results

Several statistics needed to be examined first before proceeding to factor analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy tests whether the partial correlations among items are small. The recommended value of the KMO index for suitable factor analysis is 0.5. Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate.[10,11] The *p*-value greater than 0.05 indicates that the results are not significant and that the correlation matrix is an identify matrix.

The KMO index and the results of Bartlett's test of sphericity on the data analyzed are shown in Table 1. The KMO index was 0.827, which was much higher than the recommended value for suitable factor analysis.[10,11] The Bartlett's Test of Sphericity was also statistically significant, given Chi Square = 3092.831 and *p*-value = 0.000, indicating that the correlation matrix was not an identity matrix and the data was suitable for factor analysis.[10,11]

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.827
Bartlett's Test of Sphericity	Approx. Chi-Square	3092.831
	df	666
	Sig.	0.000

Interpreting the factor analysis results involves the examination of which variables are attributed to a factor. The pattern matrix after the factor analysis is shown in Table 2. The pattern matrix holds the loadings, namely, the regression coefficients. Each row of the pattern matrix is basically a regression equation where the standardized observed variable, i.e., the item, is expressed as a function of the factors. We requested that absolute coefficients less than 0.2 be suppressed while reporting the results, and the pattern matrix exhibited a simple structure except for items 1 and 14. However, these two items could be considered as loaded on a single factor if their loadings less than 0.3 on other factors are ignored. It is normally recommended that a factor must have at least two or three variables so that it can be given a meaningful interpretation[10,11]. The factor was named based on the contents of the survey items clustered together in a group. The outcome of the EFA was interpreted as follows:

- Factor 1 was named as Problem Solving/Logical Thinking since all items in this group reflected problem solving and logic thinking ability. Items 31 and 32 in this factor had lower loadings and their contents did not fit the construct of this category, they were removed.
- The item loadings on Factor 2: Engaging Stakeholders were reasonably high and none were deleted.
- For Factor 3: Value Creation only items 7 and 8 were retained. Although item 9 appeared to have a good loading, its content did not really fit this group. Nevertheless, we retained this item in the instrument due to its high loading. A few more new items can be generated to go together with item 9 under a factor named Risk Assessment in the next round of instrument design.
- Factor 4: Gain Entrepreneurial Mindset had three highly loaded items and no modification was needed.
- Factor 5 Ability to Learn has three items. Item 11 had a relative low loading (0.25), but was retained since it fit the meaning of the factor well. Item 12 had a loading of 1.01, loadings greater than 1.0 are possible with oblique rotations[14].
- The interpretation of Factors 6, 7 and 8, which were each loaded with two items, was quite straightforward and they were named as Analyze Market Conditions, Managing Complex Tasks and Prior Exposure to Entrepreneurship, respectively.

- Factor 9: Ability to Anticipate Technical Developments was loaded with two items. Item 6 which loaded on this factor was deleted because it had a low loading and did not fit the content.
- Factor 10: Intrinsic Curiosity had five items with moderate loadings and correlated meanings.
- Items loaded on Factors 11 and 12 were weak. Since there was no clear theme for these factors, all items in these groups were deleted.

Table 3 shows the factor correlation matrix. This matrix presents the inter-correlations between the variables studied, i.e., items. The dimensionality of this matrix was reduced by clustering variables that correlate highly with a group of other variables, but correlated weakly with variables outside of the group. The variables with high inter-correlations could well measure one underlying factor.[17] As seen from the table, most factors had weak to moderate correlations with each other. Therefore, the assumption that all factors were correlated was reasonable and the oblique rotation approach was appropriate for the factor analysis[17].

Reliability Analysis

The EFA thus far suggested a 29-item solution with all variables loaded on 10 or 11 factors, depending on whether a new factor Risk Assessment is generated. Before finalizing the structure of the instrument, the reliability of the scales needs to be analyzed. Reliability measures the overall consistency of the items that are used to define a factor. The reliability analysis was performed based on Cronbach's α, a widely used measure to assess the internal consistency of items within a factor[19]. Table 4 summarizes the results of the reliability analysis for all 10 scales. The internal consistency reliabilities range from very high (0.840) to very low (0.089).

Typically, $0.7 < \alpha < 0.8$ indicates good internal consistency among item responses on a scale, and $0.8 < \alpha < 0.9$ indicates very good internal consistency.[16] Using this standard, Scale 2, which had the highest Cronbach's α of 0.840 has very high homogeneity among the item responses. Scales 1 and 6, which had Cronbach's α close to 0.8, exhibit good internal consistency. Scales 3, 4, 9, and 10 had $0.6 < \alpha < 0.7$ and are acceptable. To improve the reliability for these scales when revising the assessment instrument design, we can add more items to each scale according to Spearman Brown's prophecy formula.[7] For Scales 5 and 8, $\alpha < 0.6$, which is unsatisfactory. More items are needed in these scales in order to improve the internal consistency. Scale 7 had a poor result with $\alpha < 0.1$ and was discarded due to its low reliability. The reliability analysis therefore led to a solution with 27 items loaded on 9-10 factors.

Discussion and Future Work

An assessment instrument was designed to measure the entrepreneurial mindset of engineering students. Such an instrument is needed to measure the growth in engineering entrepreneurship mindset of engineering students who pursue programs focused on developing such a mindset. Students who participate in various specially designed activities, projects and educational modules related to entrepreneurship education are expected to exhibit more growth in their engineering entrepreneurial mindset than those who pursue traditional engineering programs. However, an assessment instrument is needed to prove this hypothesis. Results from the use of the instrument should provide insightful information to engineering educators and policy makers.

Based on the literature and KEEN's framework, an assessment instrument with 37 items loaded on 15 theoretical factors was first designed. This survey was administered to both freshman and senior engineering students. A preliminary study showed that these two groups demonstrated some differences between their responses. One of the future studies will be to analyze the differences, including the differences for each item between the two groups, and the differences between the factor analyses based on the two sets of samples. The analysis reported in this paper was based only on the freshman group. After applying exploratory factor analysis to the instrument, a model with 27 items loaded on 9-10 factors was extracted. However, improvement of the current instrument design is needed. First, we need to increase the reliability of some scales in the resultant model by adding more items. The number of items needed will be calculated using the Spearman Brown prophecy formula. Then the hypothesized model obtained from the current EFA study will be further tested through confirmatory factor analysis. Once the hypothesized model is verified, it will then be applied to measure the entrepreneurial mindset of both freshman and senior engineering students in the Tagliatela College of Engineering at the University of New Haven. A statistical analysis will be performed to compare the difference between freshmen and seniors. We expect to see a significant growth in entrepreneurial mindset by the time students complete their programs. The instrument will be shared with other engineering colleges.

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Table 2. Pattern Matrix

Factor Interpretation	Pattern Matrix	Factor											
		1	2	3	4	5	6	7	8	9	10	11	12
Problem solving/logical thinking	Q13. I am able to act effectively and creatively in difficult situations	0.498											
	Q14. I am able to use the means at my disposal to handle situations	0.349									~~-0.32~~		
	Q23. I am able to tell if it is technically feasible to develop a new product or service	0.368											
	Q24. I am able to apply logical thinking to gathering and analyzing information	0.833											
	Q25. I am able to apply logical thinking to designing and solving problems	0.687											
	Q31. I am able to substantiate claims with data and facts	~~0.319~~											
	Q32. I have a clear plan for my professional development	~~0.317~~											
Engaging stakeholders	Q28. I am able to identify potential stakeholders for a new product or service		0.720										
	Q29. I am able to address stakeholder interests in a business plan		0.849										
Value creation (Risk Management)	Q7. I think business value creation is the company owner's concern			0.552									
	Q8. I am able to define an engineering problem in terms of value creation			0.392									
	Q9. I think business risk assessment is the business manager's duty			0.744									
Gain entrepreneurial mindset	Q33. My career goal is to become an excellent engineer				0.573								
	Q34. My career goal is to become an engineer with an entrepreneurial mindset				0.924								
	Q37. I'd like to take some entrepreneurship courses in college				0.453								
Ability to learn	Q11. I am able to learn from failure.					0.253							
	Q12. I believe the ability to cope with failure can be improved through					1.009							
	Q19. I agree creative thinking skills can be acquired through training					0.345							
Analyze market conditions	Q17. I pay attention to the inefficiency in the market						0.783						
	Q18. I actively think about how to correct inefficiencies in the market						0.837						
Managing complex tasks	Q22.I am able to apply systems thinking to solve complex problems							0.533					
	Q26. I am confident in leading a team to work on a project							0.419					

Table 2. Pattern Matrix…continued

Factor Interpretation	Pattern Matrix	Factor											
		1	2	3	4	5	6	7	8	9	10	11	12
Prior exposure to entrepreneurship	Q35. I have had exposure to entrepreneurship before entering college								0.731				
	Q36. There is/are entrepreneur(s) among my relatives								0.581				
Ability to anticipate technical developments	Q6. I have at least one area of interest that I am passionate about in my life.									~~-0.21~~			
	Q15. I have the ability to anticipate technical developments by interpreting surrounding *societal* trends									0.860			
	Q16. I have the ability to anticipate technical developments by interpreting surrounding *economic* trends									0.750			
Intrinsic curiosity	Q1. I have a keen sense of curiosity.							~~-0.30~~			0.547		
	Q2. When I see a complicated piece of machinery, I always like to find out how it works										0.439		
	Q3. I always actively seek as much information as I can in a new situation										0.313		
	Q4. I consider myself to be a person who takes action when I'm curious about something.										0.512		
	Q5. I find myself being curious about a lot of things and people I encounter in life.										0.526		
These groupings are weak. There are no clear themes that emerge.	Q10. I have no idea how to assess business risk											~~0.321~~	
	Q21. I believe a problem can be understood better if it is considered in											~~0.308~~	
	Q27. I always maintain a good interpersonal relationship in a team											~~0.505~~	
	Q20. I sometimes have innovative ideas for products or services												~~0.262~~
	Q30. I am able to communicate an engineering solution in economic terms												~~0.278~~
	Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization.												

Table 3. Factor Correlation Matrix

Factor	1	2	3	4	5	6	7	8	9	10
1	1									
2	-0.11	1								
3	0.08	-0.16	1							
4	0.21	-0.11	0.08	1						
5	0.14	0.09	0.1	0.23	1					
6	0.22	-0.39	0.19	0.17	-0.05	1				
7	0.09	0.01	-0.14	0.08	0.03	-0.04	1			
8	0.17	-0.17	0.05	0.22	0.06	0.26	0.14	1		
9	-0.37	0.33	-0.2	-0.22	-0.1	-0.34	-0.07	-0.27	1	
10	-0.42	0.03	-0.11	-0.31	-0.28	-0.14	-0.06	-0.17	0.29	1

Table 4. Cronbach's α

Number	Scale 1	Scale 2	Scale 3	Scale 4	Scale 5	Scale 6	Scale 7	Scale 8	Scale 9	Scale 10
Name	Problem solving/logical thinking	Engaging stakeholders	Value creation	Gain entrepreneurial mindset	Ability to learn	Analyze market conditions	Managing complex tasks	Prior exposure to entrepreneur-ship	Ability to anticipate technical developments	Intrinsic curiosity
Items	13,14,23,24,25, 31,32	28,29	7,8	33,34,37	11, 12,19	17,18	22,26	35,36	6,15,16	1,2,3,4,5
Cronbach's Alpha	0.800	0.840	0.631	0.692	0.5	0.777	0.089	0.598	0.685	0.674

Appendix A: Survey Questionnaire

Background on Engineering Entrepreneurial Mindset of Freshmen Survey

You are invited to participate in this survey to assess the Engineering Entrepreneurial Mindset of UNH engineering freshmen. We are conducting this survey as part of the engineering entrepreneurship initiative in the Tagliatela College of Engineering at the University of New Haven. Your participation will help us to improve this initiative.

It will take you approximately 20 minutes to answer the questions in this survey. We prefer you to write your name so that we can conduct follow-up studies as needed. Personal information will be strictly protected and will not be released in any way. Your honest answer to this survey will also be kept strictly confidential. It will not be released to your instructors and your grades will not be affected in any way.

If you have further questions about this survey, you may contact Dr. Ron Harichandran, Dean of the TCoE at rharichandran@newhaven.edu. If you have any questions about your rights as a research participant you may contact the Institutional Review Board (IRB) at UNH. The IRB is a group of people who review research studies to make sure they are appropriate for participants.

Thank you very much for your participation in this study.

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

Student Name (Please Print) __________________________________ Date of Birth _____________________________
Student Signature ____ Date ____________________________________
Instructor/Person Obtaining Consent ____________________________ Date ____________________________________

Assessment of Engineering Entrepreneurial Mindset of UNH Engineering Freshmen

Definition: An entrepreneur is a person who starts a business and is willing to take on a greater than normal financial risk in order to do so.

Please rate your level of agreement with the following questions:

		I don't understand 6	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
1	I have a keen sense of curiosity						
2	When I see a complicated piece of machinery, I always like to find out how it works						
3	I always actively seek as much information as I can in a new situation						
4	I consider myself to be a person who takes action when I'm curious about something.						
5	I find myself being curious about a lot of things and people I encounter in life.						
6	I have at least one area of interest that I am passionate about in my life.						
7	I think business value creation is the company owner's concern						
8	I am able to define an engineering problem in terms of value creation						
9	I think business risk assessment is the business manager's duty						
10	I have no idea how to assess business risk						
11	I am able to learn from failure						
12	I believe the ability to cope with failure can be improved through training						
13	I am able to act effectively and creatively in difficult situations						
14	I am able to use the means at my disposal to handle situations effectively						
15	I have the ability to anticipate technical developments by interpreting surrounding *societal* trends						
16	I have the ability to anticipate technical developments by interpreting surrounding *economic* trends						

17	I pay attention to the inefficiency in the market						
18	I actively think about how to correct inefficiencies in the market						
19	I agree creative thinking skills can be acquired through training						
20	I sometimes have innovative ideas for products or services						
21	I believe a problem can be understood better if it is considered in relation to the whole						
22	I am able to apply systems thinking to solve complex problems						
23	I am able to tell if it is technically feasible to develop a new product or service						
24	I am able to apply logical thinking to gathering and analyzing information						
25	I am able to apply logical thinking to designing and solving problems						
26	I am confident in leading a team to work on a project						
27	I always maintain a good interpersonal relationship in a team						
28	I am able to identify potential stakeholders for a new product or service						
29	I am able to address stakeholder interests in a business plan						
30	I am able to communicate an engineering solution in economic terms						
31	I am able to substantiate claims with data and facts						
32	I have a clear plan for my professional development						
33	My career goal is to become an excellent engineer						
34	My career goal is to become an engineer with an entrepreneurial mindset						
35	I have had exposure to entrepreneurship before entering college						
36	There is/are entrepreneur(s) among my relatives						
37	I'd like to take some entrepreneurship courses in college						

Demographic Data About Yourself:

Name: ____ Student ID: _____________________________

Major (check the correct one):

Computer Science/Information Technology ___ Electrical Engineering/Computer Engineering ___

System Engineering ___ Mechanical Engineering ___

Civil Engineering ___ Chemical Engineering/Chemistry ___

General Engineering ___ Undecided ___

Second major or minor (if there is one): _________________________

Gender: ___________________ Age: ___________________

Residence:

Domestic ___ International (indicate your country) _________________________________

Have either of your parents earned a college degree?

Yes ___ No ___

Do you have formal work experience?

Yes (how many years?) ___ No ___