Using an intention-uncertainty matrix to categorize entrepreneurship education offerings

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Introduction

As the demand for entrepreneurial engineering students has increased in recent years, so has the availability of entrepreneurship education for engineering students (Shartrand, Weilerstein, Besterfield-Sacre, & Golding, 2010). As educators and researchers have sought to understand and articulate the benefits of entrepreneurship education, it is clear that there is a lack of agreement on what can be expected of an engineer who participates in such programs (Wheadon & Duval-couetil, 2014). For an entrepreneurial engineering program to be successful, do graduates need to start new ventures, or just understand the process? Do they need to understand how to act entrepreneurially within large engineering organizations? What if they start a business in a non-technical field? Has the program failed if its graduates never really participate in any entrepreneurial endeavors, but leave school with better professional skills and business acumen?

This paper argues for a broad definition of entrepreneurship programs that encompasses a wide range of outcomes and pedagogies. It proposes a framework for categorizing entrepreneurship education programs to create a common language among researchers, administrators, and students. With these categorizations, entrepreneurship programs can identify their intended outcomes and align them with the needs, experience levels, and career intentions of their students.

The proposed framework attempts to address and create a bridge between two major debates concerning entrepreneurship education for engineers. It seeks to demonstrate and describe four major types of entrepreneurial learning based on the degree to which venture creation is an expected outcome of the learning, and the level of uncertainty in the value proposition of the opportunity. Given that entrepreneurship takes on vastly different forms depending on these two dimensions, it is little wonder that researchers and practitioners in the field confront difficulties in defining major ideas, identifying best practices, or measuring and comparing programs' success.

Rationale for the Framework: Two Great Debates

Among entrepreneurship education researchers and practitioners, there are varying definitions and descriptions of most, if not all, of the central ideas in the field. Attempts to specifically define entrepreneurship, innovation, or entrepreneurial mindset have been attempted by many researchers and practitioners (Bilen, Kisenwether, Rzasa, & Wise, 2005; Ferguson & Ohland, 2012; Haynie, Shepherd, Mosakowski, & Earley, 2010; Kleine & Yoder, 2011; Petersen, Jordan, & Radharamanan, 2012; Wang & Kleppe, 2001), but there appears to be a disconnect in the different approaches.

In comments made at academic conferences and summits concerning entrepreneurship education and engineering, two major debates continually resurface despite the extensive work that has been done to define entrepreneurship for engineering students. The first is whether or not entrepreneurship education only concerns venture creation. Entrepreneurship is often equated with the starting of new ventures, and many measures of the success of entrepreneurship programs are focused on students' venture-creation activities after graduation (Rideout & Gray, 2013).

On the other side of the debate are educators and researchers who have documented many other benefits to entrepreneurial engineering education. Some of these benefits include increased

engagement in engineering coursework (Ohland, Frillman, Zhang, Brawner, & Miller, 2004), broader professional and business skills, including those required by ABET criterion 3 (Duval-Couetil, Kisenwether, Tranquilo, & Wheadon, 2013; Ochs, Lennon, Watkins, & Mitchell, 2006; Wheadon & Duval-couetil, 2014). In addition, intrapreneurship has become a greater focus as firms recognize the need for employees who can find new opportunities and create value internally.

Much of the conflicting thought on entrepreneurship education could probably be attributed to this debate. The course offerings, pedagogical approaches, and curricular content of entrepreneurship programs will differ vastly based on whether its administrators fall on one side of the debate or the other. The assumptions, measurement instruments, and methodological approaches used by researchers will also vary substantially based on their position in this debate.

The other great debate in recent years is an outgrowth of new methods that have been introduced in entrepreneurship education and practice. These methods, although existing in some form in business literature for decades (Mintzberg & Waters, 1985), have been popularized more recently as "Lean Startup" or "Lean Launchpad" methods (Blank & Dorf, 2012; Ries, 2011). The advent of these new approaches has created turbulence among educators and researchers. Many have been quick to "go lean" and discard methods that favor a more traditional planning approach, while others have argued for the need to preserve some of the strategic and educational benefits of the analyses and processes in business plan creation that can be translated into professional skills for engineers (Wheadon & Duval-couetil, 2014). Rather than posing these two approaches against each other, researchers need to bridge the divide between them and describe the types of scenarios in which each can be effective.

In one of the most popular and influential business books of the past two decades, Christensen (1997) describes the two different types of innovations as *disruptive* and *sustaining*. He shows that established firms tend to be very successful at finding, and capitalizing on, sustaining innovations. These innovations are improvements upon earlier products along the dimensions that current consumers value. They tend to be bigger, better, faster, flashier versions of previous products. They are somewhat predictable and expensive, and are, therefore, easily targeted by large, well-funded R&D labs in existing corporations. Disruptive innovations favor new entrants because they provide value in new ways that are seen as less desirable by current customers but reach an unknown group of non-consumers. Disruptive innovations happen in more uncertain circumstances and are more easily created and exploited through open-ended, learning-focused, emergent strategies (Anthony, Johnson, Sinfield, & Altman, 2008).

Emergent and deliberate strategies are another area of research that differentiates along the dimension of uncertainty. Mintzberg & Waters (1985) described companies that used these different strategies and demonstrated their use depending on levels of uncertainty in the environment. In a purely deliberate strategy the intended outcome is precisely known, the environment is static, and the process required to move from the current state to the success state are clear. In a purely emergent strategy, the end result is unknown, the environment is dynamic and unpredictable, and little is known about the direction that should be taken. In deliberate strategy, the focus is execution; in emergent, the focus is adaptation through learning experience in the unknown environment. Mintzberg & Waters (1985) stress the need for managers to be aware of these patterns and to employ the correct strategies based on their situations.

Research on innovative entrepreneurs' behaviors has also highlighted the need to act in different ways based on the level of uncertainty in the business (Dyer, Gregersen, & Christensen, 2008). It identifies behaviors such as questioning, observing, experimenting and idea networking, and finds

that in the early unpredictable phase of a company's life, more entrepreneurial behaviors are needed. As the company begins to find success and scale up, however, a different set of skills is needed. These management skills favor planning, execution, prediction, forecasting, analysis of data, and optimization. This research suggests that it is valuable to create partnerships between people that lean toward each type of behavior, citing the example of Michael Dell's partnership with Kevin Rollins. Dell, the innovator, and Rollins, the manager, have often been at odds because of their different approaches, but have served to balance each other out and provide leadership that could address different types of problems at different stages of their company's growth.

The theory of effectuation describes different logic types that are employed by entrepreneurs and managers depending on the level of uncertainty (Sarasvathy, 2008). This work shows how entrepreneurs navigate uncertainty and ambiguity by using effectual thinking processes rather than predictive ones. Using effectual logic, an entrepreneur would focus on what they can do with their given means, rather than having a given goal and seeking the means to attain it. This ties closely to Mintzberg & Waters (1985) work on strategy by showing the underlying cognition of emergent strategy. By starting with the means at hand, an entrepreneur can be free to follow an emergent strategy. Using predictive logic, on the other hand, forces a person to identify a goal and predict what will be needed to reach it.

Dimension of differentiation	**Author**	**Low uncertainty**	**High uncertainty**
Type of innovation	Christensen	Sustaining innovation	Disruptive innovation
Behavior	Dyer, Gregerson, Christensen	Manager behaviors	Innovator behaviors
Strategy	Mintzberg and Waters	Deliberate strategy (traditional business planning)	Emergent strategy (lean methods)
Logic	Sarasvathy	Predictive logic	Effectual logic

These different perspectives on entrepreneurial action all point to the fact that under circumstances of differing levels of uncertainty, different methods are required. It stands to reason then, that entrepreneurship education will take on different forms depending on the level of uncertainty present. This demonstrates the necessity of categorizing educational offerings according to the level of uncertainty.

Given the ideological division that these two debates represent, it is critical that, as a field, entrepreneurship education is able to reconcile the differences between the different sides. Rather than arguing for why one side or the other represents "true entrepreneurship", the authors of this paper contend that many, if not all, of these activities fall under the umbrella of entrepreneurship education.

The Entrepreneurial Intention-Uncertainty Matrix

In order to provide a better alternative for defining and discussing entrepreneurship education and its attendant activities, a framework for categorizing entrepreneurial learning has been developed. It categorizes entrepreneurial learning along two dimensions: Intention to start a new venture, and the level of uncertainty of the value proposition. By arranging entrepreneurial learning along the same

dimensions that are the sources of the field's major debates, it is anticipated that educators and researchers can see where their programs fit, understand the difference between their program and others, and recognize that entrepreneurship can be manifested in multiple ways.

Because of the difference in intentions and strategies involved in each part of the matrix, future researchers will have a foundation upon which they can situate their research. Researchers will not be looking for the methods that best teach entrepreneurship because they will see that methods will differ greatly depending on the intent and strategy needed in each type. Instead, research can be focused on what methods and content are most useful in different types of entrepreneurial learning.

The two dimensions create four quadrants into which entrepreneurial learning can be categorized. The matrix is shown in Table 1. The quadrants in the matrix contain examples of the types of programs that would target each type of entrepreneurial learning. The following sections will describe the rationale for using the 2 dimensions, and then discuss the quadrants and the types of educational programs or offerings that typify each.

Table 1. Categorized emphases in entrepreneurship education goals

		Current intention to start new ventures	
		Low	High
Uncertainty of value proposition	Low	Traditional business skills	Small business creation
	High	Intrapreneurship	Tech startups

Dimension 1: Intention to start new ventures

		Current intention to start new ventures	
		Low	High

Categorizing along intention to start ventures helps to differentiate between intensive startup experiences where students are guided in actively creating a new venture versus more skills-based experiences where students learn about creativity, innovation, and business skills without actually starting a venture. Prior research has shown that students enroll in entrepreneurship for a variety of reasons. These include seeking guidance on how to proceed with a venture or product idea, broader career options, general interest in the topic, desire to see if they could make it as an entrepreneur, earning additional educational credentials, and desire to take business classes (Duval-Couetil, Gotch, & Yi, 2014). Students who have high intentions to start ventures, but find themselves in more general

skill-building courses, may be frustrated by the lack of specific instructions on creating an organization. On the other hand, students who are interested in entrepreneurship, but do not currently have the ideas or the confidence to start a venture may be bored by some elements of business creation, and want more opportunities to gain transferable skills.

Instruction that focuses on low intention to start ventures will emphasize the development of entrepreneurial skills, behaviors, and thinking patterns without pushing students to actually start a firm or create a startup. By focusing on skills, such a program could prevent students from wasting time creating projections, validating with customers, or prototyping an idea they do not really care about or wish to pursue. It could also spend more time teaching students intrapreneurship concepts that will help them to find, create, and capitalize on new opportunities within existing organizations.

Entrepreneurial learning on the other end of this dimension focuses on venture creation. This type of instruction should guide students to find and validate an idea, and then iteratively test and improve their offering. Students should also learn legal, accounting, and other details that will be necessary as they start their venture. It can also provide students with opportunities to find and raise capital to fund their new enterprise.

Differentiating along intent to start ventures is useful for researchers and practitioners of entrepreneurship education. For researchers, it is important to differentiate because it changes the assumptions and expected outcomes that underlie their work. The kinds of questions that researchers ask, and the methods that they employ, will change drastically depending on whether learning is focused on firm creation. If a program or course is taught with high intention to create a new venture, measuring the success of such a course will be fairly straightforward: It will depend on how many students go on to create businesses and their economic impact. In a low intention scenario, the measures will not be as simple. Rather, they may focus on measuring students' ability to handle uncertainty, knowledge of business processes and strategy, ability to generate novel solutions to a problem, or communication skills.

There is also value in this type of categorization for administrators and educators. By clearly articulating this difference, programs and courses can more easily align the intentions of the program, the instructors, the assessments, and the students. This will prevent students with intentions to start ventures being disappointed by a lack of depth in a course focused on building entrepreneurial skills or mindset. It will also help students who do not already have ideas for new ventures to find courses and programs that will teach them to think and act entrepreneurially, even when they intend to work in an existing organization. With clear differentiation between these types of offerings, students can make better choices about the courses and programs in which they participate and enroll in the activities that best meet their needs.

Dimension 2: Level of uncertainty

		Current intention to start new ventures	
		Low	High
Uncertainty of value proposition	Low		
	High		

As stated previously, various strands of research on entrepreneurship and innovation point to the fact that entrepreneurs tend to use certain strategic patterns more than non-entrepreneurs. Although these researchers study different facets of the entrepreneurial experience, their findings indicate definite patterns. It is apparent that predictable scenarios require different approaches from highly uncertain ones. The level of uncertainty or predictability governs the type of strategy that should be employed, which will dramatically affect the content to be taught and the methodological approach of the instructor.

Low intention/low uncertainty

		Current intention to start new ventures	
		Low	High
Uncertainty of value proposition	Low	Traditional business skills	
	High		

The top left quadrant of the matrix represents low intention to start new ventures and low levels of uncertainty. The types of entrepreneurial activities in this quadrant will be focused on general business acumen and knowledge. These will not necessarily be focused on the creation of novel ideas or entities, but will equip students with the business knowhow that is required to be an effective part of a business organization. Traditionally, engineering students have been able to access these types of offerings through business schools or engineering management programs, but they are more recently receiving them through entrepreneurship programs.

Although this category seems less exciting or novel than some of the others, it can be an important element of an engineering student's educational experience. It is becoming increasingly important for engineering students to be conversant in business language and proficient in management skills as they are increasingly being employed in non-industrial, or non-technical, positions (Wei, 2005). Better understanding of the overall business has been a noted benefit of graduates of engineering and entrepreneurship programs (Duval-Couetil & Wheadon, 2013).

Low intention/high uncertainty

		Current intention to start new ventures	
		Low	High
Uncertainty of value proposition	Low	Traditional business skills	
	High	Intrapreneurship	

The bottom left quadrant represents low intention to start new ventures, but high uncertainty in the value proposition. This type of educational offering will prepare students to work within existing organizations, but to help those organizations to find and exploit new opportunities. They will need to be well-trained in entrepreneurial thinking and behavior and understand the types of innovations that will provide the organization with new growth.

These types of programs or courses are not often clearly defined. Instead, intrapreneurship is often considered to be a side-effect of teaching entrepreneurship to students who do not go on to create firms. There are obvious similarities between ways that entrepreneurs create new ventures and intrapreneurs create new value within firms, but the current lack of focused instruction on intrapreneurship ignores the differences between them. The two types differ greatly in terms deadlines, fundraising, available resources, existing constraints, and many others. Although Christensen's (1997) seminal work describes the advantages that smaller firms have in pursuing disruptive innovations, little work has been done to describe the different skills needed to pursue them in existing versus new enterprises.

This is especially unfortunate considering the increasing demand in industry for engineering students who think and solve problems entrepreneurially. More and more, existing corporations recognize the need for employees who can create new opportunities for growth. By learning about emergent strategy, effectual logic, and how to capitalize on disruptive innovations, students will be prepared to make decisions and add value in increasingly turbulent environments and unpredictable corporate scenarios.

High intention/low uncertainty

		Current intention to start new ventures	
		Low	High
Uncertainty of value proposition	Low	Traditional business skills programs	Small business creation
	High	Intrapreneurship	

The top right quadrant represents educational offerings with high intention to start ventures and low levels of uncertainty. Entrepreneurial activity in this space will appear similar to small business creation and management programs. These offerings will equip students with the skills and knowledge required to create a small business in which the value proposition and business model are already proven. Instruction focuses on the learning how to analyze an existing local market to see if another business of their type could be profitable.

For engineering students, this could be forming a local structural engineering firm to bid on design and building projects, or opening a small manufacturing shop to provide parts for a nearby auto manufacturer. It is not a novel idea, but is valuable to customers and can provide employment for the students. The skills needed in this quadrant are different from the others and will focus on the details of small business creation such as legal, payroll, liability, cost estimation, bidding, negotiation, and market analysis. They may also include specialized technical training such as how to practically use engineering principles to create detailed structural plans for an office building.

High intention/high uncertainty

		Current intention to start new ventures	
		Low	High
Uncertainty of value proposition	Low	Traditional business skills	Small business creation
	High	Intrapreneurship	Tech startups

The last quadrant is most commonly associated with modern technology startups. It consists of high intention to start a new venture and high uncertainty. In this space are offerings that focus on teaching students how to create and find new opportunities and create new ventures around the new offerings. These are considered areas of high uncertainty due to the novelty of the students' innovation. If it is a truly innovative offering, there will be very little knowledge about its ability to create new markets or the willingness of customers to pay for it. This is why it is important for these activities to promote emergent strategies and effectual thinking patterns.

In comparison with activity in the bottom left (intrapreneurship) quadrant, this quadrant should be more focused on providing students with understanding of new venture creation. In addition to learning to think and act in uncertain circumstances, students in this type of offering should learn how to raise capital, what types of capital they should seek at different stages, how to price offerings, creating an organization, and hiring the right people, among others.

This type of offering is often found in intensive startup experiences or entrepreneurial accelerators. Such programs are natural homes for Lean Launchpad or Lean Startup programs due to their focus on venture creation and quick, iterative validation and improvement of concepts.

Implications

Categorizing entrepreneurship education offerings as outlined in this paper could have positive impacts on stakeholders. Researchers, program administrators, and students can benefit from differentiating between activities with varying intentions and levels of uncertainty.

For researchers

Researchers in entrepreneurial engineering education have had great difficulty in creating consensus around the definitions, intentions, and outcomes of entrepreneurship education. Given the vast differences between offerings described in this paper, it is no wonder that such is the case. With this type of categorization available, researchers will be able to move past definitional boundary work by acknowledging different types of entrepreneurship, focus on the best practices in each type, and situate their research in relation to others'.

Debates over definitions of entrepreneurship and what really counts as entrepreneurship have been repeated for decades. Rather than fighting for one definition or another, it is much simpler to make entrepreneurship an inclusive term that includes many different subtypes and categories. By differentiating entrepreneurship education offerings as this paper has, researchers can move

from debating *what counts* as entrepreneurship education to *what works* in different types of entrepreneurship education.

Once the differences between the types of educational offerings are understood, it will be easier to identify and disseminate best practices. Without categories, researchers find that what works in one program does not work as well in another. They find it impossible to compare programs with each other, or to get beyond anecdotal reports of successes and failures that they hope will benefit others. Armed with meaningful categories, researchers can find different best practices for different types of offerings. They may find pedagogical methods and curricular tools that will be beneficial to some types of entrepreneurial education and not others, but if they have good categories, they will be able to understand *why* a given method works in one situation and not another.

As in many new fields of inquiry, entrepreneurship education research has often failed to create coherent understanding among researchers. Many research projects in entrepreneurship education for engineers have little grounding in prior work and little integration of similar work from other fields. It is not uncommon for researchers to fail to mention important work in cognitive science, entrepreneurial cognition, educational measurement theory, engineering cognition, or behavioral economics, any of which could impact the way that questions and studies are framed. For these reasons, it is important that researchers in the field have ways to situate their research in relation to others. The framework in this paper can be an important part of developing a shared language that researchers can use to relate their ideas to others in the field, even if some of those others are situated on the opposite end of the dimensions outlined.

For administrators and students

A major benefit of this type of categorization is the ability for administrators of programs to clearly articulate the intents and outcomes of their programs. Instead of saying that a program equips engineering students with entrepreneurship skills, and administrator can describe their programs' focus within entrepreneurship. Articulating the focus of a program or course is important because it helps to align objectives across multiple courses and instructors within a program, it gives prospective students a clearer view of what they are getting into, and it helps administrators describe what an engineering entrepreneurship program at their institution is (and what it is not).

Alignment of objectives is an important element of effective education practice. In any course, the course content, assessments, and pedagogical practices should be aligned to improve learning and to have valid understanding of the students' progress. This is more difficult across a whole program with multiple instructors and course offerings, but it becomes almost impossible if the outcomes are not clearly defined. The multiple definitions of entrepreneurship create many more opportunities for confusion and misalignment across programs. By articulating the particular type of entrepreneurship education being offered, administrators can better ensure that coursework across the program reflects the desired outcome of the institution or department.

Having clearly articulated outcomes and intentions for offerings also helps to align students' goals and desires with their educational experiences. A student who has a commercializable idea

and needs guidance to bring it to market would be very disappointed with a course situated on the *low intention* end of the matrix. A student who intends to work for a large corporation may find that a Lean Launchpad course would push them to go through the motions of creating a company, when they really hoped to gain project management skills or learn how different parts of a corporation interact and relate to each other. By better describing the types of offerings available, students will be able to choose courses that are aligned with their needs, intentions, and entrepreneurial readiness.

In addition to better describing offerings to others within the program and prospective students, articulating the different intents of different entrepreneurship types can benefit the adoption of these types of programs. As entrepreneurship education initiatives grow and develop in many universities, there are a number of obstacles to wider adoption. One such obstacle is pushback from other engineering faculty who do not think that entrepreneurship education has much to do with teaching students to be good engineers in their field. This can be explained by a lack of clarity concerning what entrepreneurship is. If a civil engineering professor sees entrepreneurship as focused on making new social smartphone apps, it makes sense that entrepreneurship would seem irrelevant. By describing the type of entrepreneurship being practiced, such as one that equips students with thinking skills that help them to navigate goal ambiguity and uncertainty, it is possible that resistant faculty may gain better understanding of the benefits of entrepreneurship education for their students.

Practical Application

For the sake of clarity, this paper has discussed the different types of entrepreneurship in stark contrast to each other. In reality, these categories are not all-or-nothing, black or white. Real engineering, social, and economic problems are neither completely predictable nor completely unknown. All action to create new value will use elements of predictive and effectual logic. To best prepare students, instruction needs to provide them with opportunities to practice both types of strategies.

Additionally, educational offerings rarely focus solely on skill development or on venture creation. A course that focuses on venture creation will need to help students develop new skills, and a skills-focused course may teach skills in the context of venture creation.

Rather than choosing one type or the other, administrators of programs should use this matrix to determine and communicate where their focus lies. There may be institutions that prefer to specialize in one quadrant of the matrix over others. Others may find that they want to cover all aspects of entrepreneurship, but have different courses that cover each part of the matrix. It is not important that programs become “purists” in one form or another of entrepreneurial education, but programs should be able to articulate where they fall on the spectra that make up both dimensions of the matrix. By clearly stating their intended focus, programs can better align their instruction and assessments, researchers can better situate their findings, and students can make more informed choices about the courses and programs in which they enroll.

Conclusion

It is clear that the emerging field of study concerning entrepreneurship education needs more organization. It needs a framework in which multiple definitions of entrepreneurial education activity can be situated and related to other work in the field. This paper proposes a scheme for categorizing educational offerings based on the intention to start new ventures and the level of uncertainty in the value proposition. By so doing, this work is intended to create a broader definition of entrepreneurship education and create meaningful categories across which researchers, practitioners, and students can have clearer understanding and consensus concerning the benefits of, and best methods for, entrepreneurship education for engineers.

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