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Instilling an Entrepreneurial Mindset through IDEAS Studio Courses

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Instilling an entrepreneurial mindset through IDEAS Studio courses

ABSTRACT

Over the last three years, we have developed 5 elective courses called IDEAS studios to instill an entrepreneurial mindset in our students. The IDEAS studios focus on practical engagement with topics that include opportunity recognition, customer engagement, design thinking, ideation, fabrication, and scaling. In designing the IDEAS studio courses, we have recognized seven characteristics that we suspect facilitate student growth in non-cognitive attributes related to an entrepreneurial mindset. The non-cognitive attributes include curiosity, intrinsic motivation, persistence, and a growth mindset. In this paper we describe these seven characteristics, their specific implementation, and why we believe they have an influence on an entrepreneurial mindset.

We conducted a pilot assessment study to determine the effect of these courses and the seven characteristics on intrinsic motivation and curiosity. We provide brief results of the study in this paper, which show that the IDEAS courses positively affect both curiosity and intrinsic motivation.

Keywords: Curiosity, Intrinsic Motivation, Entrepreneurial Mindset

1 Introduction

It is widely recognized that success in professional settings relies on more than technical expertise. The term "non-cognitive skills" encompasses personal traits other than those that are analytical (like facility with mathematics) or intellectual (such as ability to critically compare two novels) - traits such as motivation, self-efficacy, and effort[1]. Non-cognitive skills have been shown to be important contributors to student success in higher education in general and in engineering in particular. For example, in a meta-analysis of the relationship between motivation and academic success, 22 of 28 studies found a positive relationship[1]. Within engineering programs, both motivation[2] and conscientiousness[3] have been found to positively influence student persistence.

We do not advocate the teaching of these non-cognitive skills in engineering courses to the exclusion of technical content, but we do believe that the technical learning is complimented by an additional focus on student's non-cognitive development.

The Entrepreneurial Mindset and Non-Cognitive Skills

The definition of an entrepreneur has been, and will continue to be, debated[4-10]. What has emerged in the literature, however, is a constellation of attributes, actions, and experiences that when combined together in a unique way, seem to form an individual entrepreneur. First, entrepreneurs often work on problems and in spaces where others have not ventured. As such the rewards are unknown and the risks are often high. Second, there is only now a growing network of mentors and no defined recipes for success. Entrepreneurs must create their own pathway step-by-step. Third, failure is viewed as simply a wrong turn, something to be remembered and learned from, not a dead end. Fourth, an entrepreneur is driven to bring value to the world by making changes to the world around them. Unlike some others, they seem to gravitate toward making change in the most interdependent and dynamic spaces within the world. As such they engage with the complexity of the world and quickly adapt as the world changes. Fifth, bringing about changes in these complex spaces requires being able to make many coordinated and diverse actions. Rather than being an expert in one very narrow domain, most entrepreneurs are proficient in many skills and several domains of knowledge. What is more, this list of attributes of entrepreneur is certainly incomplete and there currently is neither agreement on the characteristics of an entrepreneur nor reliable, valid ways to measure these characteristics.

As described, if an entrepreneur had to meet all these criteria to succeed it would seem unrealistic , if not impossible, to succeed as an entrepreneur. Furthermore given the personal sacrifice and effort required, it is not clear why someone would want to become an entrepreneur? Even if the desire is there, how could an individual sustain the emotional stresses of such a life? These questions are important to address, not only because many do choose to become entrepreneurs, but given that much discussion in national policy circles is focused on the importance of innovation and entrepreneurship. Furthermore the entrepreneurship education community believes that being an entrepreneur is something that can be learned by anyone. If this is true, there must be some internal fuel for the desire, abilities and life-style of an entrepreneur.

Given the broad range of entrepreneurial attributes, the concept of a mindset is being proposed as a central, organizing feature of what it means to be an entrepreneur. Like entrepreneurship itself, a mindset is a construct that is ill-defined and in flux. Thought leaders agree, however, that an entrepreneurial mindset is composed of a multi-dimensional and overlapping set of personal characteristics that support and map to the constellation of attributes and skills of an entrepreneur[7,11]. For example, entrepreneurs must be aware of the shifting landscape around them. This requires constant *curiosity* that will drive a person to continually expand and update their understanding of the real world. It is this understanding of the world, gained through curiosity, that is the source of new opportunities, the generation of value propositions, and the

recognition of when it is time to pivot. As another example, entrepreneurs must be able to resist the distractions of short-term, known rewards. It is *intrinsic motivation* that enables the entrepreneur to stay focused on what drives them rather than letting the world tell them where to place their energies and talents. Many other components of an entrepreneurial mindset have been proposed, and include but are not limited to grit, resilience, growth orientation, and self-efficacy[7,12-14]. What is perhaps most important, however, is that regardless of the exact makeup or definition of a mindset, these personal characteristics can be applied not only to entrepreneurship but much more broadly to design, research, professional development and personal fulfillment.

For the educator, the construct of a mindset presents a question that will drive the remainder of this paper. Do our educational systems merely select individuals with pre-existing mindsets or can they foster the growth of a mindset? In this reframing of the "nature vs. nurture" debate we take the point of view that possessing and developing an entrepreneurial mindset are not mutually exclusive. It is the view of many educators, including the authors, is that a mindset can be learned in classroom settings[15,16]. From this perspective, the purpose of a university course is not simply to teach skills and knowledge, but also to foster mindset growth[17]. Given these foundational assumptions it is then important to identify, what kinds of environments and experiences will seed and then amplify the many components of a mindset?

In this paper, we describe five elective courses - IDEAS Studio Courses - that have been created to foster mindset growth and several common attributes of these courses that we believe facilitate such growth. In Section 2, we briefly describe the topical themes in the IDEAS Studio courses and then present common attributes of the courses in Section 3. We present the results of a study focused on measuring student curiosity and intrinsic motivation while engaged in the IDEAS Studio courses in Section 4 and discuss these results briefly in Section 5.

2 IDEAS Studio Courses

The IDEAS Studio courses are elective courses taught through the College of Engineering at Bucknell University and are designed to engage students in authentic, project-based work with students in multiple disciplines. A core goal of the IDEAS studio courses is to grow students in an entrepreneurial mindset, while students are encouraged to learn new skills that they have not yet acquired through coursework or other experiences. Entrepreneurially minded topics within the courses span opportunity recognition, ideation, creativity, fabrication, business models, value creation, and market analysis. All courses have elements of engineering design and students are strongly encouraged to leverage their discipline-specific training. There are few prerequisites for the courses to allow a wide spread of disciplines and class years. All of the courses are equivalent to 2 credit hour so that students may take the courses in addition to their required

disciplinary-specific curriculum. In the following paragraphs we provide brief descriptions of the courses.

Building Your Ideas

Building Your Ideas is an introduction to the process of product design and development from idea formation through prototyping. The course includes a one hour lecture focusing on the components of the product development process (e.g. opportunity recognition, ideation, market analysis, design, intellectual property), and a two hour practical lab that emphasizes prototyping skills and techniques including CAD, 3D printing, laser cutting, CNC machining, welding, casting, and microcontrollers (Arduino). The lecture and lab content are complementary, and designed to provide the information and tools needed to identify product opportunities, assess product potential, and develop appropriate hardware prototypes. The goal of the course is to provide all students with the information and skills needed to make informed decisions as they develop their product ideas, either as an independent inventor or as part of a larger team.

Concept to Commercialization

The Concept to Commercialization course explores the pathway from the front end of design to the tail end of commercialization. The course is driven by a project that meets identified needs of a customer and results in a product or service to deliver value to that customer. Ideally, this project involves an industrial sponsor to provide authentic input. Student teams are interdisciplinary and multi-year (sophomore through senior). In the course students learn to empathize with users, identify nascent opportunities, and generate concepts that create value. They engage a large number of potential customers, presenting to them minimally viable products to obtain immediate (and often negative) feedback on their ideas and presentation. This helps to refine their ideas and to more deeply understand what will bring value to their customers. The course culminates with a deep dive into detailed market research, engineering design, costing, value pricing, and profit forecasting.

Product Archeology

The Product Archaeology course is an examination of device design by unearthing the technical and business decisions that are made in bringing a real product to market. The course is driven forward by a product archaeology canvas that has been previously published[18,19] and is focused on intrapreneurship. The canvas is used to make a backward pass on a real device, where students explore viewpoints of the device that include product dissection, competitive analysis, intellectual property, financial forecasting, marketing, sales, distribution, industry standards, project planning and socio-cultural impacts. The canvas is then used again in a forward pass, where students project forward alternative future value propositions for the device and then make a recommendation to the company on the best direction to take with the product.

Creative Systems Design

The Creative Systems Design course blends entrepreneurially-minded topics such as creativity, ideation, and value with mechatronic systems design. Students gain practical familiarity with microcontrollers, sensors, and actuators while learning systematic ideation techniques to create value through device design. The interdisciplinary course is comprised of students from various engineering disciplines who are encouraged to develop new skills outside of their home discipline. The course leverages open-source platforms available, as students learn to integrate hardware and software.

Should we start this company?

"Should we start this company?" is a student-project centered course in entrepreneurship, generating new business ideas, and technological product or service design and development through business planning. During the course students developed a Business Strategy including Business Plan, Business Model, and Feasibility Evaluation, for both their own business idea or a client. Students also identify their customer base and do market research, including surveying if appropriate. Stretch goals included proposals for expanding capabilities of the product or service, optimizing production or delivery, and identification of new market share. The culmination of the course is to present the groups' business ideas to investors and judges (business pitch competition), and use feedback and knowledge gained from these presentations to make a final report including an analysis of the businesses' potential for success.

Students enroll from all disciplines of engineering, from the School of Management, and from across the university. The course outcomes directed students to recognize successful entrepreneurs as being capable in areas in which successful engineers should also be skilled: effectively collaborating in a team, thinking critically and creatively about ambiguous (ill-defined, open-ended) problems, being able to construct and effectively communicate a customer appropriate value proposition, persisting through and learning from failure, and managing projects through commercialization or final delivery.

3 What attributes of the IDEAS courses that we believe affect non-cognitive skills.

In the previous section we described the IDEAS Studio courses. The courses are distinct from other curricular offerings in that they blend entrepreneurially minded topics with technical engineering. We have also identified seven common attributes of the courses that distinguish them from many typical courses. We believe that these attributes contribute to development of non-cognitive skills mentioned earlier in this paper. In this section we describe the seven attributes with some specific examples. In Section 4 we briefly present results of assessment that

demonstrate the effect of these attributes on two specific non-cognitive skills – intrinsic motivation and curiosity.

*Attribute 1: Each IDEAS studio is **voluntary**.*
All students enrolled in the IDEAS courses have elected to be in the course, and for most students, the course does not contribute to degree requirements outside of serving as a free elective. IDEAS courses bear the equivalent of 2 credit-hours so that students can elect to take the courses while still meeting demanding curricular requirements. In generating and maintaining motivation and curiosity, we believe that it is important for students to make intentional selection to be in the course, learning about the anticipated outcomes, and being invested in a topic of real interest to them.

*Attribute 2: Most IDEAS studios result in a **physical artifact**.*
While only one of the IDEAS courses (Building Your Ideas) focuses specifically on "making," almost all courses involve some type of physical prototyping. In *Concept to Commercialization*, students create minimally viable products to get immediate customer feedback on their ideas. Systems integration of real components is at the heart of *Creative Systems Design*. Projects that involve a physical artifact help engineering students understand the practical implication of design decisions and while providing a solid link between disciplinary specific knowledge and how they can be applied to real systems. Physical artifacts are also important to non-engineering students in that physical artifacts provide a concrete anchor to the technical that is more tangible than more abstract representations such as CAD drawings or circuit diagrams.

*Attribute 3: Students in IDEAS studios are motivated by a **real problem**.*
We seek to make the IDEAS studios as relevant and authentic as possible by giving student real problems to work on. Some of these problems are provided by industrial sponsors, while in some cases, students work on ideas of their own. In both situations, it is important that students engage with realistic aspirations and constraints. As with all industrial sponsored projects, it is important that the projects align with the educational outcomes of the courses. For example, a semester-long project in the Concept to Commercialization involved the development of a technology-push Business-to-Customer product for an industrial sponsor. The course goals included both front-end design (customer empathy, opportunity recognition) and tail-end considerations (value pricing, costing) in addition to technical design. The project fit squarely into the scope of the course and gave students an amazing experience in working closely with the industrial sponsor on a real problem.

*Attribute 4: Students apply **broad perspectives** to their work.*

In addition to focusing on the technical aspects of project work, students in the IDEAS studios are encouraged to consider broader perspectives to understand how their efforts influence and are impacted by global, societal, and economic drivers. We provide instruction on design thinking, encouraging students to practice empathy with users and to look beyond their current circumstances and locality. Students are also encouraged to consider the tail-end of scaling and implementation. Often in the IDEAS studios, students struggle with the idea of how to deliver value to users through new product development. Most students are most accustomed to thinking about 18-22 year olds on a college campus, but in the project work, they have to consider a much larger target customer base to identify meaningful opportunities for innovation. At the same time, they must consider the effect of their decisions on economic viability, whether their design solutions will make a meaningful impact on people's lives and society at large.

*Attribute 5: Students are encouraged to utilize an **open process** to their work.*
Rather than following a deterministic algorithm toward a solution, students in the IDEAS studios are encouraged to explore multiple pathways to identify and solve problems. This exploration is important because it has potential to lead to new discoveries and gives students room to look at problems through different perspectives. At the same time, encouraging an open process can be unsettling for students who are not accustomed to it. Students must persevere through open-ended problems with no clear solution or pathway to a solution.

Attribute 6: IDEAS studios are interdisciplinary.
The courses are open to all disciplines in engineering, and some cases, to all majors throughout the university. The mix of students working together is thus interdisciplinary. Students benefit from multiple disciplinary perspectives on the same project, while the projects themselves are best accomplished by leveraging multiple expertise areas. Students learn to speak the "language" of the different disciplines, and gain greater respect for the perspectives of those outside of their home disciplines. This helps to facilitate the broader perspectives (Attribute 4) that we seek to facilitate in the IDEAS courses. In a single project for the Concept to Commercialization course, students divided up tasks with mechanical engineering students exploring mechanical design, manufacturing, and materials, a chemical engineering doing heat transfer analysis, an accounting student performing revenue forecasting, and a Markets Innovation and Design student composing market analysis. The end result was a much more holistic approach that leveraged each discipline, while exposing each student to the richness of other disciplines.

*Attribute 7: The number of students in the IDEAS studios is **small**.*
In most cases, enrollment in the IDEAS studios is limited to 16 students (with the exception of *Should We Start This Company*, which typically has closer to 35 students). Having a small number of students in the IDEAS studios enables greater interaction between the course instructor and students and make certain pedagogical approaches (such a project based learning)

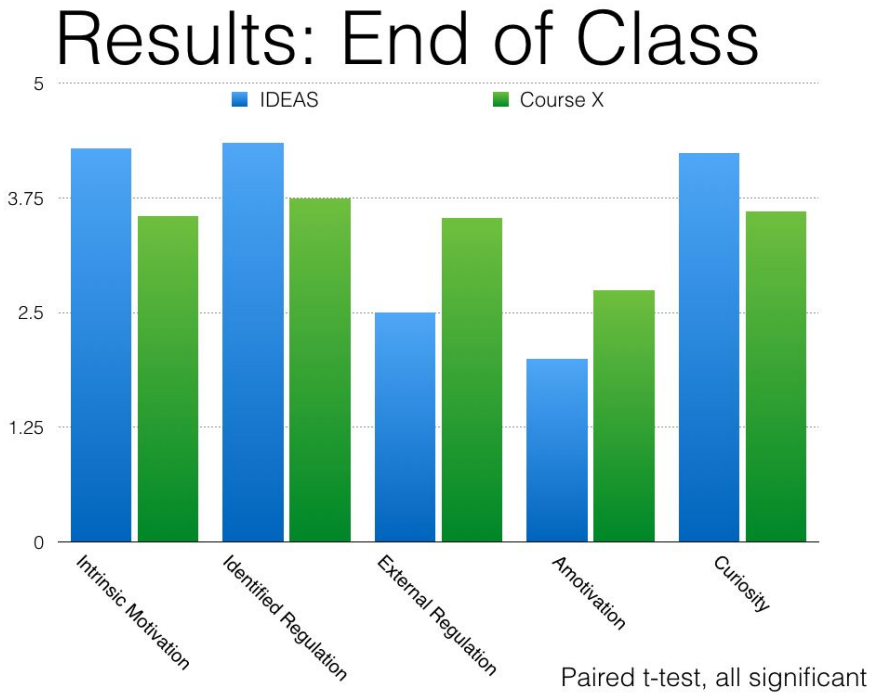
more tenable. Increased interaction may also have the added benefit of building deeper relationships, a critical factor in college learning according to Chambliss[20].

4 Results from the study

We invited students enrolled in IDEAS courses to respond to a survey including both the Situational Motivation Scale[21] and five questions from a Situational Interest Scale[22] (SIMS) to assess situational curiosity. The motivational scale tracks student's levels of intrinsic motivation ("I'm doing this because I want to"), identified regulation ("I'm doing this because it's good for me"), external regulation ("I'm doing this because I have to"), and amotivation ("I don't know why I'm doing this). Students were asked to consider how their most recent IDEAS class meeting made them feel, as well as how they felt in a comparison course (Course X) which in their view shared as few of the seven course attributes as possible. Students independently selected Course X. Because the courses were both interdisciplinary and inter-class, it would not be possible to have all students select the same Course X. At the end of both the IDEAS course and Course X, students filled out a survey to indicate which of the course attributes each course possessed. At the end of the semester, students indicated the extent to which they perceived the seven attributes to be present in both the IDEAS course and Course X. This will allow us to account for the fact that Course X's design is (intentionally) unknown and should not be assumed to either have or lack each attribute. Another important function of Course X is to help control for personality - if a person is (or is not) dispositionally motivated or curious, it should show up in both courses and differences should be attributable to elements of the courses themselves rather than the student.

Students' responses from the survey at the end of the semester is shown in Figure 1 below. It might be assumed based on self-determination theory that intrinsic motivation will always be higher in an elective course, however, we anticipate that would show up on an instrument relating to motivation towards courses overall, not on an instrument such as SIMS that looks at situational motivation - how students felt about *that day's* class activities.

Figure 1: Average score in each area , n= 54. See also Nottis et al[23].



Students experience higher levels of intrinsic motivation, identified regulation, and curiosity in IDEAS courses than in Course X, and higher levels of external regulation and amotivation in Course X. While the results shown are from the last survey in the course, the trends for results from the start of the semester and midsemester are the same, and may be seen in greater depth in Nottis et al[23].

The seven course attributes were not exclusive to IDEAS courses; students reported that some of the comparison courses were electives or created a physical artifact, for example. However, all seven attributes were typically not present in Course X, while they more often were present in IDEAS. While in an observational study it is not possible to determine causality, the motivational and curiosity outcomes seen here are correlated (Figure 1) with the aggregate of the seven attributes, and in future work we will analyze each factor independently to assess its connection to motivation and curiosity. In the future study we hope to discover how each of the course attributes contribute to situational curiosity and motivation. For example, are the students *only* motivated because they have self-selected into the course, or do the other factors also play a significant role?

5 Discussion

The IDEAS Studio course blend entrepreneurially-minded topics such as opportunity recognition, value, ideation, and other business-related topics. Yet covering the topics may not necessarily affect student mindset. Theoretically, a student of engineering or entrepreneurship could learn all of these topics by reading books or participating in a MOOC. What then is the role of the structure and pedagogy in the classroom?

In this paper we presented seven attributes of the IDEAS Studio courses that we believe affect non-cognitive skills associated with an entrepreneurial mindset. When coupled with relevant knowledge and skills, these non-cognitive skills are critical to success and essential to an entrepreneurial mindset. Deeper intellectual engagement leads to richer outcomes and greater student learning, and it is this engagement for which educators strive in course design. Often, decisions on course design are out of the control of the individual instructor, but there are some that fall squarely with within the purview of course design and pedagogy. The majority of the attributes identified in Section 3 are of this type. The study described in Section 4 (and more in detail in Nottis et. al[23]) shows that the attributes have a positive effect on intrinsic motivation and situational curiosity. The seven course attributes are certainly not the only ones that influence non-cognitive skills, and there is further research that needs to be done to more clearly articulate the specific effect of each attribute on non-cognitive skills. Yet this work begs the question of whether we should look more holistically at content, pedagogy, and structure if we intend to grow student mindsets in addition to their skills and knowledge.

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