Instilling the Entrepreneurial Mindset in Engineering Undergraduates at Baylor University

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Abstract

In today’s economy it is important for graduating engineers to be informed about business practices and product creation. At Baylor University, the School of Engineering and Computer Science has been involved with the Kern Engineering Entrepreneurial Network (KEEN) with the goal of graduating “engineers with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work.” This is accomplished by exposing students to the topics of Curiosity, Connections and Creating Value (3 C’s). At Baylor University this is done several ways. Engineering students can take part in the Technical Entrepreneurship Initiative which can lead to a Technology Entrepreneurship Certificate (TEC) on their transcript. This track, offered in conjunction with the Hankamer Business School, allows students to substitute traditional courses in economics and technical writing with a course in global business economics and another in entrepreneurship. The paper will describe the course sequence leading to the TEC and look the program’s viability as well as its impact on the graduates. In addition, several other KEEN related initiatives will be discussed, such as faculty development of the entrepreneurial mindset through workshops and a “KEEN Innovator” program which develops classroom modules using the 3 C’s.

Introduction

In today’s economy, the future looks bright for engineering graduates. Even with the emphasis on STEM education it seems that not enough engineers can be supplied to meet future requirements. Half the engineers in the power industry will be retiring in the next five years and civil engineering is expected to grow 19% by 2020 due to a boom in new construction and the need to replace the country’s aging infrastructure. Some projections show the United States will need nearly 250,000 engineers over the next 10 years to work in high growth sectors and industries such as oil and gas, aerospace, and renewable energy. This means an almost 11% expansion in the U. S. engineering labor market through 2023. The shortfall of engineers translates to a need for over 46,000 more civil engineers and 25,500 more mechanical engineers over this time period. Median starting salaries are $53,400 with the 2013 National Association of Colleges and Employers salary survey showing that seven out of the top 10 highest-paying bachelor’s degrees belonged to engineers. According to Tim McAward of Kelley Services, graduates need more than just traditional skills.

“Aside from needing traditional technical skills, employers will be seeking more engineers who are creative and can innovate and apply new thinking, says Kelly Services, as future engineering challenges will be more complex and global in nature. New technologies also will influence demand for engineers who have specialized skill sets in
embedded software, advanced manufacturing, and energy technologies, among others, and who can solve problems in nontraditional ways that include crowdsourcing (contributions by the general public).

Soft skills, such as ability to verbally communicate with others, obtain and process information and analyze data, and organize work and make decisions, will also be big differentiators among engineering career candidates. Favored will be those engineers who understand how organizations "really tick," express themselves clearly and professionally, show strong teamwork and project management, and are flexible to changing demands, according to Kelly Services' outlook.

When one person has all of those capabilities, he or she is no longer just another engineer, but [a] sought-after engineering talent."

Even with the proposed abundance of jobs available for engineering graduates, to become competitive for these positions requires students to distinguish themselves in more than just academics. At career fairs on the university campuses, human resources recruiters today find many students with very high GPAs; however, they are looking for high GPA students who have other elements in their resumes. Often desired are students who are part of design, build, and test activities such as the SAE Baja Bug, the Basic Utility Vehicle (BUV) competition, the AIAA Design Build Fly Competition, the ASME Student Design Competition or the ASME Human Powered Vehicle. There are any number of competitions that a student can be involved with but the desire of perspective employers is still the same. Students involved with these competitions gain organizational skills, learning how to comply with requirements and timelines, and the physicals skills necessary to design and fabricate the object for competition. Leadership of student professional societies, such as IEEE, ASME, ASEE, SAE, etc. is also valued. All of these skills are seen as very desirable to future employers.

Thus, the competition for the more desirable and higher paying engineering jobs will depend on what a student has accomplished over and above their basic engineering degrees. In order to function within an industry as an engineering professional, students must have a basic understanding of the internal workings of a business, to include organization and economic analysis. The engineer needs to understand how they can function within their work environment and add value to the company. This is absolutely essential if an engineer desires later in their career to enter management. Informed engineers can encourage new hires and help them thrive in the industry environment. Many engineers go on to earn an MBA degree at the eight to 10 year point in their career just prior to entering the management progression. Other engineers may have the desire to develop an idea into a new product or service. Their understanding of the business cycle is necessary to insure success. While most students will not develop a new product, it is important to the economy to have engineering entrepreneurs who can create value with new endeavours.
Board of Advocate Emphasis
It is apparent that additional training for engineers in the operation of industry is of importance. This gives graduates an edge that makes them more marketable. A recent Board of Advocates (BOA) meeting for Baylor University School of Engineering and Computer Science (ECS) focused on this need. Over the past few years the school has been encouraged by the BOA to develop this dimension to the curriculum. More specifically, the recent fall meeting had a breakout session to discuss a better integration of the entrepreneurial mindset into the school. The BOA saw value in what they could contribute with their expertise to the program to include the following list:

1. Innovative idea incubator
2. Guest speaker in classes to emphasize business skills
3. Bring in more alumni to express their transition experiences
4. Look for more resources off campus to tap into for contributions.
5. More BOA involvement in Senior Design experiences
6. Topical discussion like case studies involving BOA
7. KEENternships – allowing faculty opportunities to intern at businesses
8. Funding of initiatives that the BOA could support to further this dimension

These initiatives are being developed and further reinforce the desire of the BOA, many of which are employers of Baylor ECS graduates, to increase a student’s understanding of business and business practices.

ABET Accreditation
There are several ways where this emphasis intersects with the need to assess students for ABET. Baylor has been privileged to be part of the Kern Entrepreneurial Engineering Network sponsored by the Kern Family Foundation (KFF). The KEEN mission “is to graduate engineers with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work.” KEEN student outcomes have as their goal the development of an entrepreneurial mindset among engineering students. This is characterized as shown in the table below.

<table>
<thead>
<tr>
<th>An Entrepreneurial Mindset</th>
<th>Characterized by</th>
<th>Shown by these actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curiosity</td>
<td>Demonstrate constant curiosity about our changing world</td>
<td>Explore a contrarian view of accepted solutions</td>
</tr>
<tr>
<td>Connections</td>
<td>Integrate information from many sources to gain insight</td>
<td>Assess and manage risk</td>
</tr>
<tr>
<td>Creating Value</td>
<td>Identify unexpected opportunities to create extraordinary value</td>
<td>Persist through and learn from failure</td>
</tr>
</tbody>
</table>
These topics overlap considerably with many of the current ABET student outcomes a-k. ABET outcomes are being revised. The most recent proposal has them reduced to the following 1-7.

“The program must have documented student outcomes. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7) plus any additional outcomes that may be articulated by the program.

1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.”

The 3C’s shown above appear to map very well into the new ABET student outcomes. This is important because it means that some assessment of entrepreneurial work can also be used to help with ABET assessment. One of the authors is part of an assessment committee within KEEN that is developing more detailed mapping between the KEEN student outcomes and the new ABET student outcomes.

Another way in which this work relates to ABET is that Baylor University’s Mechanical Engineering program has changed its undergraduate mission statement. The current ME undergraduate mission statement is:

“The mission of the Mechanical Engineering undergraduate program is to educate students, within a caring Christian environment, in the discipline of mechanical engineering. Our graduates will be equipped with the fundamental technical, communication, and teamwork skills to succeed in their chosen careers. They will be empowered by innovative problem-solving creativity and an entrepreneurial mindset. They will be motivated by Christian ideals and a vocational calling to improve the quality of life worldwide.”

The reference to being empowered by an entrepreneurial mindset was added in 2013 as a direct result of the impact of this work on our program. The official ABET program educational objectives are based on what is stated in the mission statement.
Partnership with Kern Family Foundation
Baylor’s involvement with the KFF has existed since Baylor’s first grant in 2008. As part of this grant, Baylor joined a network of like-minded schools who are interested in entrepreneurial engineering education. Baylor’s most recent grant from the Kern Family Foundation was a collaborative effort with three other universities: the University of Detroit Mercy, the University of Dayton, and Villanova University.

Kern Family Foundation
The Kern Family Foundation states that their philanthropic focus is:

“We intentionally focus on systemic change, rather than charity, by partnering with broad-impact, long-term programs that align with one or more of our focus areas.”

The Kern Family Foundation has defined their focus areas as:

- Forming good character
  - Shaping a sense of moral responsibility for one’s self, neighbour, and community, laying the foundation for a meaningful and virtuous life.
- Providing quality education
  - Equipping young people with the academic skills and virtues necessary to realize their potential and contribute to the common good.
- Instilling an entrepreneurial mindset
  - Empowering people to see the world as a place filled with opportunities to create extraordinary value.
- Rediscovering the value of work
  - Inspiring people to view their daily work as a source of personal dignity and a valuable contribution to human flourishing.

KEEN is an outgrowth of the third topic above, installing an entrepreneurial mindset. KEEN states on their website:

“In order to find jobs in a rapidly changing world, individuals require technical knowledge. They cannot, however, rely on a skillset alone if they hope to enjoy fulfilling careers.

Individuals need a mindset that adds “know-why” to technical “know-how” to contribute to the success of their colleagues and employers, as well as to create value for others.

An entrepreneurial mindset is key to personal and professional success. Engineers equipped with this mindset understand the bigger picture and, therefore, can recognize opportunities, evaluate markets, and learn from their mistakes. These engineers are capable of more than solving technical problems; they are constantly looking for unexpected ways to create value.

After recognizing the importance of the entrepreneurial mindset, our Entrepreneurial Engineering Program created the Kern Entrepreneurial Engineering Network, a collaborative partnership of colleges and universities dedicated to graduating engineers.
with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work."\(^4\)

**Current KEEN programs at Baylor University**

1. **Innovators** - Since our invitation to be a part of KEEN, one of the major emphases in each of our grants has revolved around faculty development, with the KEEN Innovators program being the major thrust of this emphasis. The purpose of the KEEN Innovators Program is to encourage the integration of entrepreneurial concepts and skills into the engineering and computer science curricula by awarding a stipend to Engineering & Computer Science (ECS) faculty members who develop a course module or modules that illuminate the concepts of curiosity, connections, and creating value within the course(s) he/she teaches.\(^8\)

The KEEN Innovators started in 2008 with two innovators, two in 2009, seven in 2010, one in 2011, four in 2014, and five in 2015. To date, twenty-one faculty members in ECS (~44% of the total ECS faculty) have participated in the Innovators program. Assessment of the usefulness of this faculty development initiative has been, and continues to be, of interest and development.\(^9-11\)

2. **Workshops** - In 2011, the KEEN Leadership team in ECS designed and developed a series of monthly faculty development seminars, with end-of-semester workshops, available to all ECS faculty.\(^12\) Topics have included:

- ECS Core Competencies
- Teaching Innovations
- Student Engagement
- Collaboration Across Academic Disciplines
- Collaboration Across Institutions
- Painstorming vs. Brainstorming
- Importance of Technical Writing in ECS
- Importance of Technical Speaking in ECS
- Assessment
- Curiosity
- Making Connections
- Creating Value
- Five Essential Elements of Effective Thinking

3. **Technical Entrepreneurship Certificate/Global Business Course** - As part of the first grant proposal in 2008 to the Kern Family Foundation, Baylor proposed the design and development of a certificate program in Technical Entrepreneurship (TE).\(^13\) The TE certificate is comprised of the following:

- EGR 4301, “Global Business, Economics, and Communication (GBEC),” taught in ECS,
- ENT 4340, “Technology Entrepreneurship,” taught in the Hankamer School of Business (HSB), and
- Three additional hours from one of the following (all taught in HSB):
  - ENT 4330, “Corporate Entrepreneurship,”
ENT 4353, “Social Entrepreneurship,” or
ENT 4350, “International Entrepreneurship.”

The first two courses serve as alternatives to two courses used to satisfy ABET accreditation
criteria, “Engineering Economics,” and “Technical and Professional Writing.”

The GBEC course was developed in 2007, in preparation for this next step in the growing
relationship between ECS and HSB. \(^{14, 15}\)

**Technical Entrepreneurship Certificate**

In 2009, a certificate in Technology Entrepreneurship (TE) was designed, developed, and
approved by the Baylor University Board of Regents in recognition of the fact that as the amount
of cross-disciplinary coursework increases, it is of value to students and institutions to formally
recognize the achievements and learning involved.

The TE Certificate was designed to first meet the needs of the ECS students who invest in TE
coursework, and also has the potential of attracting students from other science and technology
schools in the future. A review of several similar certificate programs in the U.S. led to the
conclusion that optimally 9 hours are needed in order to ensure sufficient rigor without in effect
becoming a minor under another name, and making it infeasible to achieve without an extra
semester. Over the past 4 years, permanent course substitutions within both Mechanical
Engineering and Electrical and Computer Engineering Degree programs have been achieved for
6 of those hours: Global Business: Economics and Communications, and Technology
Entrepreneurship. Consequently, only 3 hours are needed to be taken as “extra” course-work for
a student in either of these programs to also fulfill the requirements for this new Certificate.

The details of the program:

1. This is an official on-transcript certificate issued by the University, and administered by
   the Entrepreneurship Department in the Hankamer School of Business.
2. The requirements may be fulfilled in a few different ways, depending on the interests of
   the student:
   a. All ECS Students will take the GBEC course (3 hours). This will be the entry
course for ECS students desiring to earn this Certificate. It is a prerequisite for
taking the other courses.
   b. All ECS students will also successfully complete Technology Entrepreneurship (3
   hours). This course can be taken on the Baylor campus as ENT 4340, or as part
   of the i5 Baylor in Shanghai program as ENT 4352. This is the capstone course
   and is normally the final course in the certificate sequence.
   c. Each student will select one of the following three options for their other 3 hours
   in Entrepreneurship to earn the Certificate: Corporate Entrepreneurship (ENT
   4330), Social Entrepreneurship (ENT 4353) or if participating in i5, they will take
   International Entrepreneurship (ENT 4350)
   d. Notes: (1) Certificates are awarded only if all 9 hours are completed with a grade
   of B or higher, and (2) Entry into i5 is a competitive process and not all students
desiring this experience will necessarily be able to be accommodated.
The original proposal for GBEC was that the two courses (GBEC and ENT 4340) would satisfy the requirements for Engineering Economics and Technical & Professional Writing over the two semesters, thereby requiring students to take both courses in order to get the substitution credit.

The GBEC course is the first course in a two-course sequence that prepares students to work effectively at the interface between business and engineering in a global economy. Economic analysis (sometimes called Engineering Economics) and effective communication, both written and oral, are essential in the decision making process for introducing new technology into the marketplace. GBEC focuses on engineering economics, written communication and oral communication for engineers and computer scientists, addressing communication to both technical and non-technical audiences. These skills will be further developed by applications in the second course.

**GEBC Learning Objectives:**

1) **Economic Analysis (EA):** Students will perform various kinds of economic analysis, with a focus on engineering projects and their viability. Students prepare various financial statements including balance sheets, income statements and business ratios. The successful student will be able to:

   a) Do economic analysis using the time-value of money concepts, including equivalence, present worth, annual cash flow,
   b) Perform market value assessment, rate of return analysis, payback period, depreciation computations and equipment retirement;
   c) Make after-tax economic analysis;
   d) Prepare balance sheets, cash flow statements, and income statements, and demonstrate an understanding of their importance and differences;
   e) Understand the integration of these analytical tools to assess the cost of development and implementation of new technologies.

2) **Technical and Professional Writing (TPW):** Students plan, draft, revise, and edit various forms of written communication for different audiences and purposes common to a technical / professional context. Finished documents will include formal memorandums, technical reports, and a technical research report. The successful student will:

   a) Demonstrate an expanded understanding of technical and professional writing as a complex, iterative, recursive process: learning about and practicing rhetorical analysis, problem-solving, planning, project management, research, organization, design, drafting, sharing and responding to work in progress, revising, and editing
   b) Demonstrate the knowledge and ability to use effectively different processes to plan and produce different technical / professional genres (and their various parts) for different situations, for different purposes, and for different technical and non-technical audiences, including audiences with different cultural expectations
c) Demonstrate the skills and ability to conduct effective secondary research using appropriate library databases and credible professional resources.
d) Demonstrate an understanding of professional expectations for responsible, ethical, and appropriate use of information from other resources, including an understanding of the complexities of intellectual property rights
e) Demonstrate the ability to apply effectively the current style guidelines of a professional organization such as ASME, IEEE, or ACM, including the ability to use appropriate document design, format, and accurate, consistent citation of secondary resources
f) Demonstrate the ability to work effectively in small groups and individually to plan and produce technical / professional documents
g) Demonstrate an understanding of how global contexts, contemporary issues, and current events may affect the planning and production of technical and professional communications

3) Technical and Professional Speaking (TPS): Students will give professional, relevant team presentations that reflect enhanced understanding, skills, and strategies acquired in EGR 4396. The successful student will:

a) Demonstrate skills and strategies to improve individual and team presentations;
b) Demonstrate improved facility to incorporate technical material including visuals in presentations;
c) Give and receive relevant feedback appropriately; incorporate feedback to improve succeeding presentations;
d) Demonstrate effective techniques for interpersonal communication and teamwork; demonstrate the ability to work effectively to create and present in teams;
e) Demonstrate increased proficiency for think-on-your-feet communication (TOYF) opportunities including presentation Q/A;
f) Demonstrate ability to communicate ethically and persuasively to diverse audiences; and
g) Demonstrate ability to communicate with increased awareness and sensitivity to cross-cultural audiences.

This course is very resource intensive as it is taught in three parts that have traditionally been taught by separate professors. The economics portion of the course is typically taught by an ECS engineering professor and will be taught by an ECS Clinical Professor of Practice in the future. The writing portion of the course was taught by a professional writing professor from the Hankamer School of Business. The presentation portion of the course has been taught also by a professor from the Hankamer School of Business however, recently, these instructional presentations have been recorded digitally and this past fall the recordings were used in the classroom. Thus, this course has the propensity to be resource intensive due to the number of faculty, the number of graded assignments and the coordination required.
ENT 4340 Technology Entrepreneurship
With the completion of EGR 4301 Global Business, students in either Mechanical or Electrical and Computer Engineering can take ENT 4340 to satisfy their requirements for technical writing and economics instead of taking the standard course sequence. This course is also required if a student is seeking to obtain the Certificate in Technical Entrepreneurship. The course description is as follows:

“Business based on patentable technologies display different business models and characteristics from those of non-technical, mainstream businesses. Understanding these distinctions is critical to technology commercialization. Technology Entrepreneurship examines the entire technology commercialization process, from concept to market. It is intended to provide students in business, engineering, and the sciences with the knowledge needed to participate effectively in the processes required for the successful introduction of new technology products in the marketplace.”

In this course the student will develop an understanding of the technical innovation process, get acquainted with advanced tools to facilitate innovation, learn how to protect intellectual property, and see how these principles are utilized in industry through case studies. The strategic implications of creating new business ventures within or outside of an existing corporation will be introduced. This course is an opportunity for engineering students to be involved in developing a business plan for marketing a technology.

Students, working in teams of three, apply what they have learned in both courses by working as consultants for a company on a project that is a technology based business opportunity. This project will include economic analysis, periodic memorandums, a technical report and oral presentations for a technical and for non-technical audiences, enhancing the skills learned in the first course by repeated application. Past companies who have participated are Integrated Framing, Cbana Labs, Inc., ALI Solutions, Inc., and the Marco Company. It is a very comprehensive approach that couples business and engineering students and uses specific education tools developed for this course that were supported by KEEN. Approximately 15-20 engineering students can participate in this course each spring.

Global Business Survey Results
A series of eight questions and a number of statements with a Likert scale were administered to the fall semester class of EGR 4301 Global Business. Of the 17 students, only 16 students were present on the day that the survey was administered. The results of the survey are given below and discussed in the context of the course.

1. Why did you want to take the Global Business/Technology Entrepreneurship track instead of the traditional engineering economics/technical communication courses? – Overwhelmingly the students took this class/track because they see the value of this material to their future employment. Some students wanted to get an MBA, others wanted to start their own business, and others were more interested in the business side of industry rather than engineering.

2. Do you intend to take the ENT 4340 Technology Entrepreneurship? – 75% intended to take the course, 18.75% already took the course, and 6.25% said maybe.
3. **Do you intend to take an additional course to get the Certificate in Technological Entrepreneurship?** – 12.5% said yes, 37.5% said maybe, 37.5% said no, 6.25% already did, and 6.25% did not know about the Certificate Program.

4. **Was the solar panel scenario a good way for you to apply what you were learning in the course? Briefly state why or why not.** – 62.5% said yes, 18.75% said no, and 18.75% said somewhat. There were many criticisms of the project. Some thought it too electrical with too heavy an emphasis on solar power rather than entrepreneurship and economics. Others found the project very good but poorly implemented at times. It was a very comprehensive project that looked at business, economic, and other factors. The many writing and presenting exercises made the project seem very long.

5. **Global Business had three topical areas this semester: economics, writing, and oral presentation. Please briefly comment on the quality and level of instruction for each.**
   - **Economics** – For the most part the quality and level of instruction were adequate. The PowerPoint slides used were supplied with the textbook and were not always engaging. Students wanted more example problems as the problems used in class were textbook examples.
   - **Writing** – Use of the ASME format did not fit the project. The use of a writing expert (additional faculty) detracted from the flow of the course. Writing evaluation was very thorough and grades were not very high. One opportunity to re-write the exercise for an improvement in grade was valued. All in all, the reviews on the writing portion were mixed but tended toward being helpful.
   - **Oral Presentation** – This was accomplished with videos and the videos were not well received. The videos had good content but were not integrated into the course well. Some thought the videos were boring. Several opportunities to present were good and people learned through experience and critique. More detailed feedback was needed.

6. **What do you like best about this course? (List up to three things.)** – Group work, solar power, and oral presentations.

7. **What do you like least about this course? (List up to three things.)** – Three hour class, class not as organized, and three different professors

8. **If you were the professor, what would you do to improve the course?** – Two-half semester projects, quizzes, get a better room, use homework more, and better communication with the students.

The general consensus was the course was a success and adequately treated the topics of economics, technical writing, and oral presentation. Next, a series of statements were presented to the students and they were asked to rank the statements with a “1” being Disagree and a “5” being Agree. Average scores are reported. Table 1 shows general statements about the course appropriate to the course conclusion. Tables 2-4 addressed student perceptions of their abilities in economics, technical and professional writing, and technical and professional speaking. These statements would be better administered at both the beginning of the course and after the course.
completion to ascertain the value added by the course. From Table 1, students were confident in writing and oral presentation however, not as confident in economics. The material presented and the solar project were appropriate however, the classroom and the course expectations were not adequately addressed. It is interesting to note that the course was thought useful for future employment and that many would like to get an MBA. From Table 2, the students were confident they learned the specifics of economics from the course. Table 3 showed a high degree of confidence with writing and Table 4 showed the same with oral presentation. From Table 4 it was clear that the videos were not the most popular method of presentation.

Table 1 Global Business – General

<table>
<thead>
<tr>
<th></th>
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<th>Score</th>
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<tbody>
<tr>
<td>a</td>
<td>The course met my expectations.</td>
<td>2.63</td>
</tr>
<tr>
<td>b</td>
<td>The classroom was appropriate for learning.</td>
<td>2.88</td>
</tr>
<tr>
<td>c</td>
<td>Material presented at the appropriate level.</td>
<td>3.75</td>
</tr>
<tr>
<td>d</td>
<td>The solar project was an excellent way to apply the course material.</td>
<td>3.63</td>
</tr>
<tr>
<td>e</td>
<td>I feel confident in my understanding of the engineering economics</td>
<td>3.06</td>
</tr>
<tr>
<td>f</td>
<td>I feel confident in my understanding of engineering technical and professional writing.</td>
<td>3.81</td>
</tr>
<tr>
<td>g</td>
<td>I feel confident in my understanding of technical and professional speaking</td>
<td>4.25</td>
</tr>
<tr>
<td>h</td>
<td>Global Business is useful to my future work.</td>
<td>3.88</td>
</tr>
<tr>
<td>i</td>
<td>I would like to get an MBA in the future.</td>
<td>3.88</td>
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</tbody>
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Table 2 Engineering Economics

<table>
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<th></th>
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<th>Score</th>
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<tbody>
<tr>
<td>a</td>
<td>I understand and can apply the time value of money.</td>
<td>4.13</td>
</tr>
<tr>
<td>b</td>
<td>I understand and can apply interest rates, rates of return, depreciation, and payback periods.</td>
<td>4.06</td>
</tr>
<tr>
<td>c</td>
<td>I understand and can apply after-tax economic analysis, balance sheets, cash flow statements and income statements.</td>
<td>3.81</td>
</tr>
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Table 3 Technical and Professional Writing

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<th></th>
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<th>Score</th>
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</thead>
<tbody>
<tr>
<td>a</td>
<td>I understand and can write an Executive Summary.</td>
<td>4.13</td>
</tr>
<tr>
<td>b</td>
<td>I am confident doing secondary research.</td>
<td>4.13</td>
</tr>
<tr>
<td>c</td>
<td>I understand and can write a technical proposal.</td>
<td>4.06</td>
</tr>
<tr>
<td>d</td>
<td>I understand and can use technical writing guides such as ASME.</td>
<td>3.63</td>
</tr>
<tr>
<td>e</td>
<td>I can work effectively writing in small groups.</td>
<td>4.13</td>
</tr>
<tr>
<td>f</td>
<td>Being able to revise and incorporate edits into my conceptual paper was a valuable experience.</td>
<td>4.00</td>
</tr>
<tr>
<td>g</td>
<td>More writing assignments should incorporate the opportunity for revisions/improvements.</td>
<td>4.00</td>
</tr>
<tr>
<td>h</td>
<td>I feel my technical writing skills improved because of this course.</td>
<td>3.75</td>
</tr>
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Table 4 Technical and Professional Speaking

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<tr>
<th></th>
<th></th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>a</td>
<td>The videos prepared me for making and delivering a technical presentation.</td>
<td>2.88</td>
</tr>
<tr>
<td>b</td>
<td>I feel that I can prepare a professional PowerPoint presentation.</td>
<td>4.75</td>
</tr>
</tbody>
</table>
c. I am confident that I can work with a team to prepare a technical presentation.  4.63

d. I am confident that I can deliver a technical presentation ethically and persuasively.  4.50

e. I am able to give and receive feedback to improve succeeding presentations.  4.25

f. I am able to think on my feet to answer questions about my presentation  4.44

Alumni Comment
One alumni was kind enough to give his thoughts on what EGR 4301 added to his educational experience. This sentiment has been expressed verbally by other graduates as well:

“As an undergraduate engineer, I did not have a large appreciation for the finance side of the profession. The Global Business course introduced me to many concepts that are ever-present in my current position. I work as a structural analyst in the aerospace industry, and although the job is very technical and distant from finance, money ultimately affects every decision that we make. Making the plane lighter, reducing the number of different parts, reducing the number of operations required to make those parts, using less expensive materials, doing all of these things in the anticipated number of man hours. These are all difficulties that are weighed in our decision making every day. Tradeoffs are a key concept investigated in the Global Business course, and understanding risks and opportunities is pivotal in engineering problem solving.

Presentation skills were also stressed in the GBEC course. Communication is essential as an engineer. I spend about half of my day analyzing stresses and solving equations, doing things that 90% (an arbitrary estimate) of my education was focused on, and the other half of my day is spent in meetings presenting my findings or weighing design options with other members of the team or clients. Between GBEC and the subsequent entrepreneurship course I gained proficiency and confidence in my presentation skills that other students in the alternative tech writing course missed out on.

Overall, the class exposed me to important engineering concepts and skills that are often overlooked in many technical classes.”

Future of EGR 4301 Global Business – Economics and Communications
Expanding student enrollment in EGR 4301 Global Business is desirable. About 10% of Baylor engineering students take EGR 4301 followed by ENT 4340 “Technology Entrepreneurship.” The remaining 90% take ECO 3308 Engineering Economic Analysis in the business school, which follows a more traditional textbook approach. ECO 3308 is followed by a Technical Writing course taught in the English Department. The primary instructor for EGR 4301 will be an engineering clinical professor with deep business experience. The course has been traditionally co-taught by a professional communications instructor and technical writing instructor from the Baylor Business School.
The eventual objective is to establish 100% participation in EGR 4301 so that all students receive entrepreneurial exposure and, thus, an opportunity to evaluate their interest and aptitude for entrepreneurship. EGR 4301 would then serve as a prerequisite for ENT 4340 and the remainder of the TE certificate program. Should this be realized, the implication is that EGR 4301 would go from one section of approximately 20 students to five sections or more. To manage faculty load, the course would likely be redesigned so that business faculty teach “Textbook” elements and Engineering faculty teach “Project” elements of the course. Planning will be done in conjunction with the Baylor Business School, and with input from selected KEEN member schools and the foundation.

Conclusion

Baylor University is actively seeking to instill the entrepreneurial mindset in engineering undergraduates. This mindset will be a distinguishing characteristic of Baylor students giving them an insight into business practices and product creation. As part of the KEEN network, classroom experiences are exposing students to the topics of Curiosity, Connections and Creating Value (3 C’s). Engineering students can take part in the Technical Entrepreneurship Initiative which can lead to a Technology Entrepreneurship Certificate (TEC) on their transcript. This track, offered in conjunction with the Hankamer Business School, allows students to substitute traditional courses in economics and technical writing with a course in global business economics and another in entrepreneurship. These two courses, EGR 4301 Global Business and ENT 4340 Technical Entrepreneurship, were described to allow the reader insight into the value of these courses to Baylor’s students. A desire to grow this sequence to involve more students presents challenges with resources. In addition to these courses, several other KEEN related initiatives, such as faculty development of the entrepreneurial mindset through workshops and a “KEEN Innovator” program which develops classroom modules using the 3 C’s, are also valuable for the development of the entrepreneurial mindset at Baylor. Efforts will continue in these areas.

References