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Fostering the entrepreneurial mindset through the development of multidisciplinary learning modules based on the "Quantified Self" social movement

Dr. Eric G Meyer, Lawrence Technological University

Dr. Meyer directs the Experimental Biomechanics Laboratory (EBL) at LTU with the goal to advance experimental biomechanics understanding. Dr. Meyer teaches Introduction to Biomechanics, Tissue Mechanics, Engineering Applications in Orthopedics and Cellular and Molecular Mechanobiology. He has been an active member of the engineering faculty committee that has redesigned the Foundations of Engineering Design Projects course that is required for all freshman in the College of Engineering at LTU. This committee is currently designing a new sophomore-level Engineering Entrepreneurship Studio that will also be required for all students as a continuation of the "Foundations studio". He has published 33 peer-reviewed journal and conference proceeding articles. At LTU, Meyer offers a number of outreach programs for high school students and advises many projects for undergraduate students.

Dr. Mansoor Nasir, Lawrence Technological University

Dr. Mansoor Nasir received his B.Sc. in Electrical Engineering from University of Cincinnati and Ph.D.in Bioengineering from University of California-Berkeley. He worked as a research scientist at US Naval Research Laboratory in Washington DC before joining Biomedical Engineering department at Lawrence Technological University. He has several publications in the areas of microfluidics, chemical and biological sensors and MEMS technology. He is also passionate about engineering pedagogy and has attended several workshops on using techniques that make the classroom instruction more engaging and effective

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Abstract

Traditional engineering curriculum and coursework lacks entrepreneurial experiences for students. While most entrepreneurship program models utilize curriculum that is delivered in a business school collaboration, more recently engineering colleges have started promoting the idea that Entrepreneurial-Minded Learning (EML) can be formalized within engineering education. Development of an entrepreneurial mindset is difficult while students are actively working on their senior projects, so additional experiential learning during the earlier levels of undergraduate education is needed. In this project, we set out to include EML in courses across engineering programs and at various levels of the 'core' curriculum. EML modules were based on the theme of "Quantified Self" (QS). This is a new, exciting, real-world entrepreneurship opportunity that uses wearable sensor technology to help people understand their personal health and wellness. The goal of this project was to develop teaching resources that used the QS theme to motivate EML in a variety of academic topics.

During the first phase of this project QS modules were developed and implemented in four biomedical engineering (BME) courses at the freshman, sophomore, junior and senior levels. Direct and indirect assessment was used to gauge the effectiveness of modules at changing students' perceptions and improving their entrepreneurial capabilities. Then, these resources were shared with faculty from four additional disciplines at three different institutions to develop and implement additional EML modules across a broad range of engineering and science topics. The EML modules were multi-week assignments that were organized following Problem Based Learning (PBL) pedagogical techniques. Each module combined several open-ended tasks that built sequentially following previously completed work and the topics that were covered in class.

EML is an effective vehicle for including inductive learning pedagogies into technical engineering courses. Correspondingly, the QS theme provides real world motivation for students to engage with many technical topics. By spreading modules into a variety of different 'core' courses, students will be repeatedly exposed to each of the targeted entrepreneurship skills with an increasing levels of difficulty and expectations. These opportunity and impact recognition skills are an important prerequisite for students during their senior capstone projects.

Motivation to include "Entrepreneurial Minded Learning" in the curriculum

The goal of Bachelor of Science (BS) programs in engineering has focused on producing quality graduates with the Science, Technology, Engineering and Mathematics (STEM) and liberal arts skills necessary for engineering practice (Regets, 2006). Historically, this process followed the traditional *deductive* teaching technique of proposing a concept, explaining the principles and demonstrating mathematical models of the concept (Froyd et al., 2012). This required the student to memorize the material or work examples which was followed by testing their performance on similar work during an exam (Prince and Felder, 2006). However, traditional engineering curriculum and coursework lacks important student learning opportunities, such as; the reason why these concepts or mathematics are important, what is their real-world relevance and how this will impact the students' future career in engineering. An alternative to the traditional teaching method is *inductive* learning, which is a student-centered approach that encompasses many pedagogical methods including; Active and Collaborative Learning (ACL), Problem Based Learning (PBL) and others (Smith et al., 2005; Smith et al., 2009). These techniques begin with a real world problem or observation that is introduced to the students. The students determine that certain skills, facts, or principles are required to solve the problem and the teacher can then act as a guide to help them acquire the needed information (Figure 1). ACL and PBL techniques have been shown to be more effective at student retention of content when they are properly implemented (Prince, 2004).

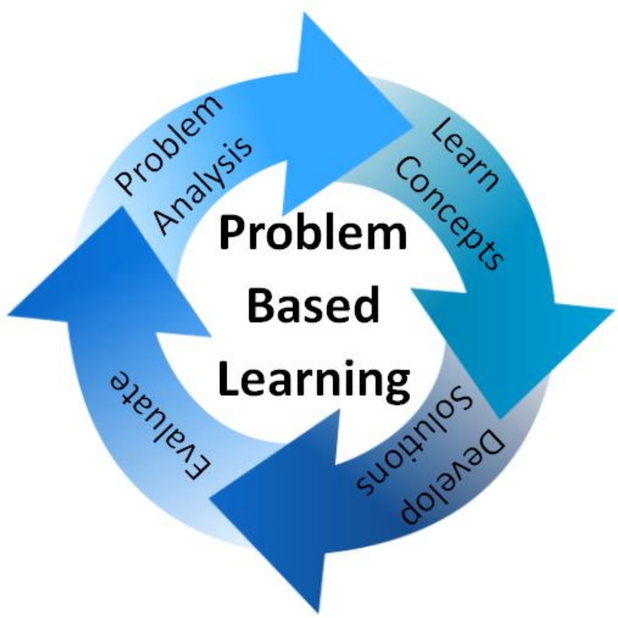


Figure 1. The Problem Based Learning pedagogical technique for course modules.

The effectiveness of STEM education in the United States has been widely debated and criticized, but there is widespread consensus on the need for innovation and high-technology to maintain our strong economy (NAE, 2004; Davidson, 2006). While engineering is crucial for innovation and technology in order to contribute to future success, many leaders have pronounced a need for reforms that enable students to be better at adapting to new trends, embracing creativity and leadership, understanding engineering impacts on society and business, as well as providing more opportunities to experience engineering design (Fairweather, 2008). Recently, networks of engineering colleges supported by the Kern Family Foundation, VentureWell (formerly NCIIA), Coleman Foundation and National Science Foundation, among others have promoted the idea that "Entrepreneurship is a Mindset" and that engineering education must teach students the entrepreneurship process (Rae, 2005; Kriewall and Mekemson, 2010).

Entrepreneurship programs directed at engineering students typically co-exist alongside the 'core' curriculum of the engineering program as minor, certificate, or extracurricular offerings (Shartrand et al., 2010). These models utilize coursework that is delivered in a collaboration between the engineering and business schools (Standish-Kuon and Rice, 2002). On the other hand a limited number of engineering schools, including Olin College, integrate entrepreneurship throughout courses in the engineering curriculum. Engineering design courses are frequently used to give students opportunities to practice entrepreneurial skills while working on real world engineering problems (Shartrand and Weilerstein, 2012). Entrepreneurial-Minded Learning (EML) pedagogy has been developed as techniques that emphasize students learning to create value, gather and assimilate information to discover opportunities or insights for further action (Melton, 2014). The EML pedagogy provides engineering faculty with a useful and effective tool for embedding entrepreneurship modules within individual technical courses. Rather than displacing technical content, EML promotes inductive learning and allows students to explore the "why", "real-world relevance", and "impact" of the problems that they are asked to solve.

Engineering graduates entering industry require business and entrepreneurial skills, so Lawrence Technological University and others, have implemented comprehensive transformations of the engineering curriculum to instill an entrepreneurial mindset in students (Carpenter et al., 2011). These developments, funded by the Kern Entrepreneurship Education Network (KEEN), included an entrepreneurial certificate program and a seminar series that were strongly tied with the business programs. Entrepreneurial education was also integrated across the curriculum, throughout engineering, science, arts and humanities courses (Gerhart and Carpenter, 2013). Starting with freshman (Gerhart et al., 2014), the College of Engineering at Lawrence Tech is currently in the process of creating a cohesive, four-year multidisciplinary engineering design program focused on creating entrepreneurially minded engineers capable of; inquisitive initiative, societal and self-awareness, impact on society, excellent communication, and exemplary project implementation (DeAgustino, 2014).

In conjunction with broader programs at the university and college levels, the goal of this project was to modify additional core curricular courses with EML in order to increase students' experience with opportunity and impact recognition skills. The embedded modules were distributed broadly across various disciplines; Biomedical, Mechanical, Electrical and Robotics Engineering and Life Sciences and at all levels of the curriculum. By adopting EML as a running theme, the students were allowed an opportunity to develop a mindset that fosters creativity and collaboration (Nasir and Meyer, 2015a).

"Quantified Self" entrepreneurship opportunity

The theme for developing these EML modules was "Quantified Self" (QS), an exciting real-world trend in large consumer electronics companies and new digital health startups. In the past few years, many QS devices have been introduced with new sensors and data logging systems to allow individuals to understand their personal health and wellness through quantification and tracking a variety of biomedical measures (Table 1). QS also includes aspects of a broad social movement including social networks and fitness communities, as well as a grassroots community (quantifiedself.com) that is interested in flipping the traditional health and wellness from a top-down model to one that inspires individuals, families and communities to gain "self-knowledge through numbers" (Wolf, 2010). These enthusiastic participants can derive their motivation from two or more philosophies; type "A" do not fully trust health and wellness books, doctors, etc… while type "B" think that the self-awareness that they gain from QS is as beneficial as the data itself.

The QS theme was initially identified because it was specifically related to the authors' areas of expertise in Biomechanics and Biosensors. Some of the readily accessible examples of biomechanics in society include; videogame control of the kinematics based Microsoft Kinect and the kinetics based Nintendo Wii Balance Board, and human computer-interaction with the kinematics based Leap Motion. Some readily accessible QS topics related to biosensors include; the inertial motion measurement based Wii Remote and various smartphone apps, electromyography based Myo Gesture, and pressure based Nike Hyperdunk in-shoe sensors. The new QS devices also raise many interesting professional and ethical questions, such as; "What constitutes a medical device?" and "What safeguards are in place for privacy and security of personal and/or health related data?"

In addition, the QS theme can be used to motivate a variety of academic topics (Figure 2). The explosive growth of QS devices has been made possible by the convergence of technologies such as sensors, computer miniaturization, big data and networks that allow widespread sharing of personal information (Figure 3). There is also tremendous growth in venture capital funding for "Digital Health" companies (http://rockhealth.com/resources/digital-health-startup-list/). The diversity of technological, social, and medical concepts easily allows this entrepreneurship opportunity to motivate a wide range of courses in many different disciplines and with any level of experience, technical difficulty and academic expectation that the faculty wishes to impart. These in-class modules are also easily expandable into higher levels of scholarship as student capstone design or into integrated research projects. On the other hand, by relaxing the technical and mathematical requirements, these activities can also work well for broader outreach programs aimed at younger students or the community at large (Nasir et al., 2014a).

Table 1. Partial list of example QS resources for students to get started.

Devices	Networks
Basis Health tracker (http://www.mybasis.com/)	Facebook Moves Exercise community (https://www.facebook.com/movesapp)
Fitbit One Activity and sleep tracker (http://www.fitbit.com/one)	Nike+ Sports and exercise community (https://secure-nikeplus.nike.com/plus/)
Withings Smart body analyzer (http://www.withings.com/bodyanalyzer/)	Weight Watchers Online Dieting community (https://www.weightwatchers.com/plan/www/online_01.aspx)
W/Me Life spectrum analyzer (http://www.phyode.com/products.html)	Fitocracy Exercise community (https://www.fitocracy.com/)
Fuelband Sportwatch GPS (http://nikeplus.nike.com/plus/products/sport_watch/)	Google+ Fitness community (https://plus.google.com/communities/105008312335704126105)
iBitz Family friendly pedometer (http://ibitz.com/)	Runtastic Exercise community (https://www.runtastic.com/)
Nike Hyperdunk+ shoe sensor (https://secure-nikeplus.nike.com/plus/products/basketball)	LIVESTRONG My Plate Diet tracking (http://www.livestrong.com/)
Apple Smart watch (https://www.apple.com/watch/)	23andME DNA analysis (https://www.23andme.com/)
Zepp Sports movement sensors (https://www.zepp.com/)	AskmeEvery Daily accountability (http://www.askmeevery.com/)
http://technori.com/2013/04/4281-the-beginners-guide-to-quantified-self-plus-a-list-of-the-best-personal-data-tools-out-there/ http://experimentable.com/qs-guide/	

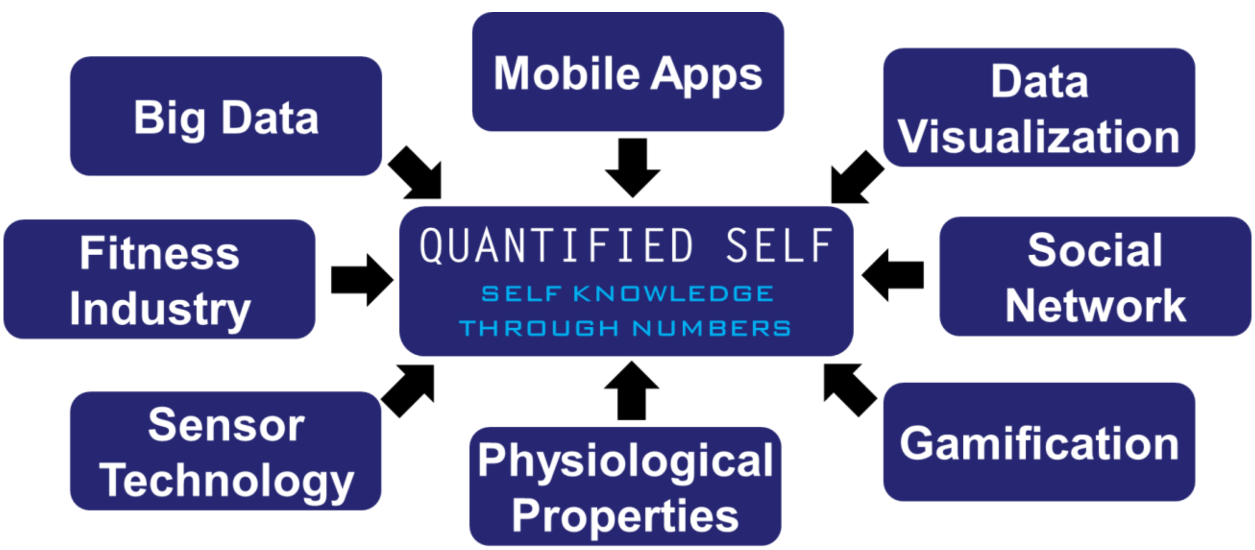


Figure 2: Graphical representation of the components of the QS movement.

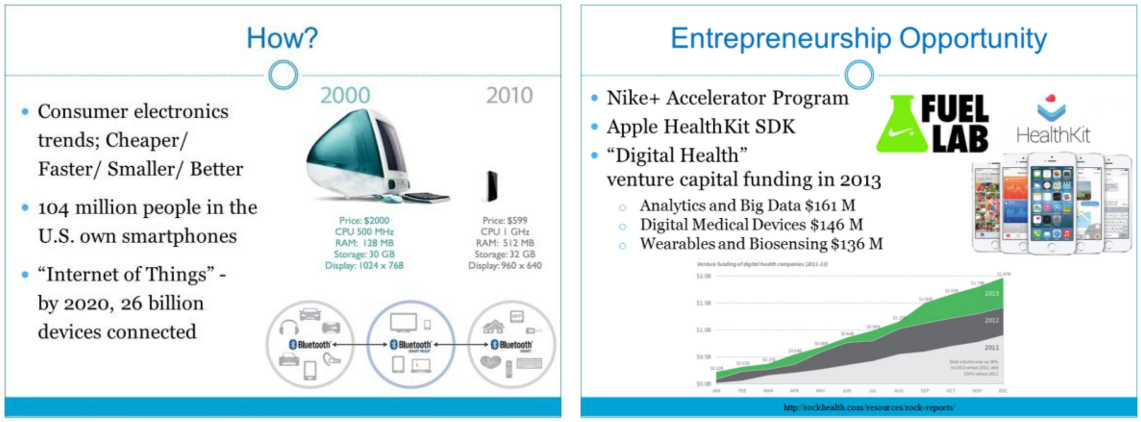


Figure 3: Example teaching slides to motivate the QS theme in EML modules.

Biomedical Engineering course modules

Biomedical Engineering (BME) is a relatively recent addition at many traditional engineering schools with an increasing number of academic institutions now offering a BS degree in BME. The field of BME merges engineering disciplines such as mechanical, chemical, and electrical engineering with biology-based disciplines of life sciences and medicine. This interdisciplinary field has been motivated by the need to improve procedures such as diagnostic testing, noninvasive surgical techniques, and patient rehabilitation and to apply quantitative analyses to biological problems (LaPlaca et al., 2001). The multidisciplinary nature of the field means that students in BME need to develop a broad set of skills and knowledge. They need the modeling and quantitative skills of traditional engineers, but they also need the systems level understanding which is representative of a more biological approach. In addition, significant opportunities exist to develop more effective, functional and affordable technology solutions to clinical medical problems that require biomedical engineers to develop an entrepreneurial mindset in addition to their scientific and technical skills (Nasir, 2014b).

In the first phase of this project, the BME program at Lawrence Tech was targeted for EML-focused modules to be embedded in four individual courses at the freshman, sophomore, junior and senior levels (Table 2). These topical modules focused on EML skills related to opportunity and impact recognition using real world problems and current trends from the QS theme. Course modules were developed using inductive learning pedagogical techniques. Direct assessment of student work and indirect assessment of student perceptions were used to gauge the modules' effectiveness at changing students' awareness and improving their entrepreneurial capabilities.

Table 2. Entrepreneurship skills coverage in course modules.

	Initial Module Development at Lawrence Tech				Multidisciplinary Module Development				
Program	Biomedical	Biomedical	Biomedical	Biomedical	Biomedical	Mechanical	Biology	Robotics	Electrical
Level	Freshman	Sophomore	Junior	Senior	Freshman	Sophomore	Sophomore	Junior	Senior
Course	Intro. to BME	BME Best Practices	Medical Device Design	Orthopedics	Fund. of BME	Statics	Physiology Laboratory	Unified Robotics III	Communication Systems
Opportunity Recognition	X		X		X	X	X	X	
Market Investigation	X	X	X	X		X		X	X
Create a Preliminary Model	X			X	X	X		X	X
Communicate solutions in terms of economic benefits	X	X						X	
Communicate solutions in terms of societal benefits	X	X	X		X			X	
Examine technical feasibility, economic drivers, societal and individual needs			X	X	X		X	X	X
Intellectual Property Protection		X							
Regulatory Issues		X	X	X					
Collaborate in a team setting	X	X			X	X	X	X	X

The BME modules were multi-week assignments that were organized as PBL activities. Each module combined several open-ended tasks that built sequentially following previously completed work and the topics that were covered in class. They included smaller in-class ACL activities with individual or group homework assignments. Additional learning opportunities came from invited entrepreneurs who gave seminars that were attended by students from multiple classes. At least two of the modules covered each of the entrepreneurship skills that were targeted (Table 2). Highlights of modules in each of the four course are described below:

BME 1002 Introduction to Biomedical Engineering

- Opportunity Recognition through "Painstorming"
- Investigation of QS devices
- Using Nike+ Shoe Sensor in a new application
  - Device Concept
  - Business Model and Market Potential
  - Elevator Pitch video on economic and social benefits

BME 3002 BME Best Practices

- "Repurposing" a QS device to solve a Global Health need
  - Medical device & patent (IP) search

Examples of QS products

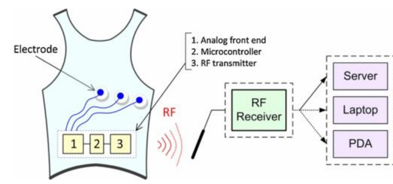
Nike+ Hyperdunk Shoe Sensors

Eclipse Self Breast Exam

- Mock 510-k (FDA) application
- Mock invention claims disclosure

BME 4113 Medical Device Design

- Bio-design process
  - Multiple Opportunity Recognition techniques; “Painstorming”, “Customer Networking”, and others
  - Investigation of clinical, technical and market feasibility
  - Engineering Design Process; Prototype / Model
  - Mock 510-k application
  - Mock patent application
  - Elevator Pitch to explain customer and economic value



ECG monitor shirt

BME 5093 Engineering Applications in Orthopedics

- Product Opportunity Creation
  - Identification of a remaining challenge and potential market impact
  - Investigation of technical issues related to orthopedics
  - Form a company
  - Medical device and patent search
  - Mock quality manual for Good Manufacturing Practice (GMP)

Sensor compression socks

At the freshman level, the module questions were simple and the expectations were largely non-technical. Some example questions were;

- What need does this device address?
- What is the value of this device to the consumer?
- Come up with one important feature that is missing from this device or think of an improvement that would make this product more valuable.

At the sophomore and junior levels, the focus of modules included more emphasis on professional skills;

- Is this device a FDA regulated ‘Medical Device’? What class of device is it?
- If not, how would you modify this device to target the medical industry?
- Construct a simplified patent with an abstract, figures/sketches and novelty of the idea.

At the junior and senior levels, there was more emphasis placed on technical principles and regulatory standards;

- Starting with your base of knowledge about the topic that you chose for your midterm report, determine one broad challenge that remains to be addressed in Orthopedics.
- What is the importance of this challenge? How large of a problem or opportunity is it?
- What is the potential impact (magnitude of change) if this challenge is addressed?
- Specify validation test protocols such as ASTM standard tests that you would use to determine the strength, fatigue life and other mechanical properties of your orthopedic device.

Assessment of student work showed that students are comfortable with written assignments, but the communication of an idea in terms of economic and social aspects was challenging. On the other hand, the survey results were inconclusive with regard to if there was an improvement in the student's perception of their entrepreneurship skills. This may actually reflect that going into the modules the students were over-confident about in their entrepreneurship knowledge and skills related to entrepreneurship and afterwards they more accurately perceived the importance of these topics for engineering, and their need for additional training and practice in this area. Some of the students have been involved in classes or class activities that focused on entrepreneurship but in most cases the perception was that this is a skillset that is acquired through apprenticeship or experience.

Some additional recommendations and improvements that were made following pilot module implementation include; continuing to recruit external speakers for entrepreneurial seminars and work with seniors and student groups to organize opportunities for professional engineering experiences, begin entrepreneurial skills training earlier in the semester, continue EML experiences throughout the semester and finish with a formal capstone assignment due during the "Quantified Self" module. Future work for this project includes implementing module revisions in subsequent course offerings. Additional assessment data will be collected and analysed to more formally determine the effect of EML on student's entrepreneurship and technical skills.

Interdisciplinary course modules

Faculty and students from four additional disciplines at three different institutions were surveyed about their experiences and perceptions with EML. Faculty collaborators were asked to fill a survey about entrepreneurship and "Quantified Self". The general findings of the survey are below:

- All faculty agreed there was not enough emphasis on entrepreneurship in programs and recognized its importance for innovation in their respective fields.
- Faculty considered Creativity and Opportunity Recognition to be most important to EML.
- PBL was the unanimously chosen as the methodology to introduce entrepreneurship.
- According to the survey, all but one of the courses already includes some innovative learning modules focusing on ACLs, PBLs and Entrepreneurship.

- While faculty members were aware of the QS devices, most had not considered how it could be used to teach entrepreneurship.

The coauthors are currently working with additional faculty to develop entrepreneurial skills modules for courses in other disciplines and at partner KEEN universities (Table 2). An initial "Kick-off" meeting was conducted to introduce the collaborators to the QS theme and how it was being used to achieve the objectives of EML. Examples of EML modules from BME courses and student feedback from the pilot modules were also shared (qs4eml.ltu.edu). The collaborating faculty developed their own modules and provided a guide for other instructors to implement the module as well as assessment methods (See Appendix for an example). Currently, these modules are being assessed through the pilot implementation. Highlights of modules in each of the four course are described below:

BME 201 Fundamentals of Biomedical Engineering (Western New England University)

- Activity tracking for 24 hours
- Assistive technologies for individuals with disabilities
  - Analysis, concept brainstorming
  - Concept selection, development
  - Elevator Pitch presentation

BIO 2201 Anatomy and Physiology Laboratory (Lawrence Technological University)

- Investigation of QS devices
  - Opportunity recognition with "Repurposing"
  - Investigation of clinical, technical and market feasibility
  - Elevator Pitch to explain customer and economic value

MECH 210 Mechanics I (Statics) (Kettering University)

- Case studies of entrepreneurship
- Business model development
- Statics sensors in the real world
- Multiple Opportunity Recognition techniques;
- Elevator Pitch to explain customer and economic value

Examples of QS products

Assistive Technologies

Heart rate monitor

Invisible helmet

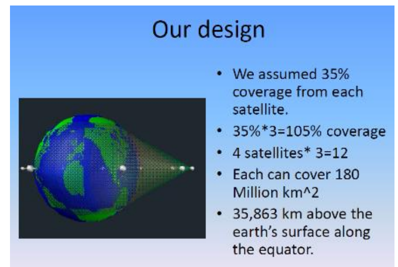
ERE 3024 Unified Robotics III
(Lawrence Technological University)

- Household robotics products
  - Opportunity Recognition; “Painstorming”
  - Market Investigation
  - Preliminary Model
  - Investigation of technical issues
  - Highlight economic and social benefits

Household robotics

EEE 4423 Communication Systems
(Lawrence Technological University)

- Global Position Services
  - Market Investigation
  - Investigation of technical issues
  - Highlight economic and social benefits



Commercial GPS

Conclusions

EML is an effective vehicle for including inductive learning pedagogies into technical engineering courses. The entrepreneurship skills that we focused on were opportunity recognition, market investigation, communicating societal and economic benefits, evaluating regulatory issues and protecting intellectual property. These skills are essential for students during their senior projects. The EML activities can be easily introduced in the course schedules and the required work was not overly burdensome. However, ACL and PBL focusing on entrepreneurship should include formal in-class follow-up activities and in-class discussions.

Correspondingly, the QS theme provides real world motivation for students to engage with many technical and professional topics. The differences between QS devices and medical devices, has recently been addressed (FDA, 2015a & 2015b) with industrial guidance that establishes three categories of oversight; not medical devices, discretion based enforcement devices, and regulated devices. By removing the FDA regulatory issues of QS devices, students may feel more comfortable being creative with finding opportunities related to biomedical engineering. Overlapping topics between courses can allow students to develop familiarity with the real world motivation and practice entrepreneurial skills with increased confidence over time. In order to avoid repetition, each course should emphasize a particular application that is directly tied to the course’s learning objectives. By spreading modules into a variety of different ‘core’ courses, students will be repeatedly exposed to each of the targeted entrepreneurship skills with an increasing levels of difficulty and expectations.

A common and serious limitation of many engineering curricula is that the first chance that many students get to work on innovative, real world ideas is during capstone senior projects. While many ideas have excellent market potential, only a handful result in the generation of intellectual property because successful entrepreneurship requires more than just a good idea. With no exposure to an entrepreneurial mindset, a common student complaint during senior projects is an inability to come up with a ‘good’ idea (Nasir et al., 2015b). Development of an entrepreneurial mindset is difficult while students are actively working on their senior projects and experiential learning during the previous levels of undergraduate education is needed.

Most students consider entrepreneurship synonymous with starting a business and therefore think that learning about it should occur in business school. On the other hand, almost all agree that it is important for engineers. Since it is unlikely that additional space can be freed up in most engineering programs for additional business courses, the strategy in many university engineering collages has been to introduce EML into the core engineering courses. This strategy takes advantage of the inherently inductive learning process of entrepreneurship to actually increase student learning of the technical course content.

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Appendix: Sample EML Module Instructor's Guide

BME 5093 Medical Device Design

Purpose of this module: Finding opportunity for a new medical device.

The course assumed basic knowledge of instrumentation and circuit analysis although the reliance on this knowledge was decreased from previous year. The project involved finding a need and then doing the background research and market investigation for it.

- Week 2
  - Lecture
    - Overview of Bio-Design Process
    - Steps in the design and development of medical devices and systems.
    - Review of opportunity and constraints
  - Handout
    - Biodesign Process chart (*Design of Biomedical Devices and System — Paul H. King*)
  - Associate Activity
    - Find the definition of given medical conditions
    - Where does this fit in the Biodesign Process Chart
    - What is the cause?
    - What is the current treatment option?
    - What is your source(s) for information?
    - How would you find more relevant information?

- Week 4
  - Lecture
    - Opportunity Recognition starts with finding a need.
    - Comparison of finding problems in education and in the real world
    - Painstorming for need finding
  - Handout
    - KEEN Complementary Skills Chart
  - Associated Activity
    - Pick one article from a Medical Technology magazine (e.g. Medical Design Briefs)
    - Describe the basics of Technology in class
  - Homework
    - Purpose: To develop an ability to describe the important aspects of a technology. This is important for an entrepreneur to a describe ideas to a layman (who could be an investor).
    - A written summary covering (i) Overview of the Technology (ii) What need does it address (iii) How was the opportunity recognized (iv) How does the device achieve its purpose (v) Who are the innovators (vi) How is the device better than competitors / Are there any competitors (vi) How is it being marketed
    - No longer than 1 page including references/sources
    - A video that must be less than 5 minutes. (25pt)

- Week 6
  - Seminar from a Serial Entrepreneur (Students required to attend)
  - Associated Activity
    - Blackboard Survey (Credit given for completion)
    - Content specific feedback related to technologies discussed
    - Entrepreneurship feedback related to complementary skills

- Week 9
  - Final Project Assignment
    - Overview of final project
    - Discussion of deadlines and requirement

- Week 11
  - Final Project – Product Opportunity Recognition
    - Students submit three ideas in written format to the instructor. The instructor evaluates the ideas, provide feedback and chooses the most one appropriate for each student / team

- Week 12
  - Seminar from an engineer at a Medical Device Company
  - Associated Activity
    - "Intrapreneur" Survey
  - Final Project – Customer Interaction and Preliminary Market Analysis
    - Students will develop a simple questionnaire. 4-5 questions that pertain to the customer needs.
    - The survey and results will be due in the final report.

- Students will also develop a value proposition simultaneously. The results of the market analysis will be due in the final report.

- Week 14
  - Final Project – FDA Classification and Intellectual Property
    - Students will use FDA regulations to determine if their device falls into a Class I or II. Class III devices will have to be reworked to class I or II
    - Students will draft a 510k submission which will be part of the final report.
    - Students will draft a one page patent with an abstract, figure/sketches and novelty of the idea. This will be included in the final report

- Week 15
  - Final Project – Elevator Pitch
    - Students will be given 60 seconds to record their idea in a youtube video in the form of an elevator pitch.
    - Summarize the idea, the customer feedback, market and value proposition in a simple and succinct manner. (Resources for effective elevator pitches will be provided in class).

- Finals Week
  - Final Project – Final Report Due
    - An abstract summarizing the device/technology idea
    - Background of the relevant area
    - Market analysis and Value Proposition
    - Survey and a summary of results
    - System Level Components of the device
    - Technical information and theory for device operation
    - Hand sketches / CAD Prototypes as appropriate
    - Challenges and roadblocks that are anticipated in the implementation of idea
    - FDA Classification and 510k submission
    - Sample Patent based on the technology
    - References

- Final Exam
  - One question pertaining to Medial Device Entrepreneurship
    - Randomized the medical needs developed by the student for their final reports to other students in the class and asked questions about (i) Background research (ii) Customer base (iii) Target for feedback (iv) Potential challenges (v) A different design.

Supporting materials:

- Lecture Presentations
  - BioDesign Process (Lecture 3B)
  - Opportunity Recognition (Lecture 8B)
- In class activities
  - Definition Activity (Medical Terminology)
  - Medical Design Mag Activity
- Surveys
  - Entrepreneurship Survey
  - Intrapreneurship Survey
- Assignments
  - Homework 2 – Technology Review and Video
  - Final Project – Medical Device Opportunity Recognition
  - Final Exam – Entrepreneurship Question
- Rubrics
  - Technical Presentation
  - Final Report