Teaching Entrepreneurship to Engineers

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Abstract—This paper describes the authors' experiences in teaching entrepreneurship courses to MBA students (many of them engineers) through the Nottingham University Business School in Singapore and Malaysia and then adapting the material for undergraduate engineering students at Michigan Technological University and the University of Nottingham. The course integrates a foundational understanding of entrepreneurship with a practical "how-to" approach. It surveys the basic elements of business startup and identifies many useful resources and just-in-time tools. Unique to the course is a focus on the underlying thinking skills, and the students are taught the process of lateral thinking and an iterative model of creative problem solving that can result in a commercial product and a sustainable business or can increase the innovation potential in an existing company. Key to the course is immediate application in a team class project (and for the MBA students, a follow-up application after the end of the course, to be submitted as a mini case study). Feedback from the MBA students indicates that many feel encouraged and prepared to start their own businesses—a process that can take months or years depending on the location, type, and complexity of the planned enterprise and product to be developed. The course has been an eye-opener as to the skills and resources required to achieve their dreams of "being their own boss" and running a profitable company—of moving "from brain to market." Outcomes with engineering undergraduate students are less clear-cut but encouraging. At Nottingham, enrollment in a modified version of this course (with hardly any advertising) increased from 95 students in 2002 to 187 in 2003. The emphasis on thinking skills together with rigorous learning assessment requirements appears to be significant to the success of this enterprise course.

Introduction

The importance of startup companies to economic growth is well known. Entrepreneurs form the lifeblood of a healthy economy. They drive business, lead innovation, and create new jobs, new wealth, and new opportunities, and thus they help improve the quality of life for many. From 1948 to 1998, entrepreneurs have led the US out of every recession (nine in all) according to US Department of Labor data. However, this has not been the case for the current rough-and-tumble economy. Reasons for this lag are not clear, but what is clear is that we need more entrepreneurs/technopreneurs/intrapreneurs who understand change and have the skills that increase the odds of success. Engineers can become an important driving force for business startup, business success, and innovation if they understand the dynamics of entrepreneurship and the relationship to specific thinking skills.

While entrepreneurship education has existed in the Unites States for more than 50 years, with approximately 1500 institutions now offering some form of entrepreneurship training,[1] entrepreneurship education is by and large still on the fringes. Most universities today offer at least one course in entrepreneurship, primarily through their Business School. The concept of

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teaching engineers and scientists to be entrepreneurs (or technopreneurs) is still relatively new. Technopreneurship—the merging of knowledge in technology with entrepreneurship skills—requires not only technical knowledge but also a thorough understanding of creativity, the innovation process, marketing, finance, and strategic thinking. Links between Engineering and Business Schools remain very weak on many if not most US (and UK) campuses, and therefore it is mostly left to the students to seek out and synthesize the courses and information they need to become entrepreneurs. Traditionally, students complete a technical program and then study for an MBA. Unfortunately, many MBA programs do not teach its students the skills needed to become entrepreneurs. Ultimately, to be effective, the teaching of entrepreneurship must be integrated with research (which includes a serious study of entrepreneurship) as well as service activities in order to create an enterprise culture that will permeate the academic institution and serve as a role model for regional economic development.

It is difficult to believe that the issue of whether entrepreneurship has a place in engineering education is still in debate. Yet, feedback from many engineering students in such courses indicates that "it has been the most useful/best course in the entire curriculum" regardless of the student wanting to become an entrepreneur or not. This paper will present the experiences and insights from a cooperative effort between an engineering and a business professor in teaching entrepreneurship to graduates and undergraduate students, many of them in engineering.

The thinking preferences of entrepreneurs

Typically, engineers (and engineering faculty members) have strong preferences for analytical, logical, quantitative thinking, often coupled with very structured, procedural thinking.[2-4] The retention in engineering programs of students who "think differently" is rather dismal,[3] yet these conceptual, holistic, inventive thinkers are those most likely to be drawn into an entrepreneurship program. Several important questions then arise:

1. What kinds of thinking preferences are found among successful entrepreneurs?
2. If there is a promising path to entrepreneurship for various types of engineers (and there is, as will be shown in this paper), then how can engineering students (and faculty) be motivated toward entrepreneurship?
3. Do engineering students—because of their predominantly analytical mindset—require special teaching approaches in entrepreneurship courses?

Webster's Dictionary defines entrepreneurs as "persons who organize and manage a business and assume the risk for the sake of profit." However, when seen through the lens of thinking skills, things are not quite that simple. In Joseph Schumpeter's view, a person is an entrepreneur only when generating a wave of innovation or catalytic change that causes acceleration in economic development.[5] According to the Austrian school of economics, entrepreneurs are alert to opportunities for profit in response to changing demand or supply.[6] Thus, the ***catalytic*** entrepreneurs derived from Schumpeter's analysis create new production possibilities, for example with a new invention, whereas the ***allocating*** entrepreneurs from the Austrian school of thought put these new ideas into practice in a variety of practical applications. Consequently, these two types of entrepreneurs exert pressure on existing businesses that are then forced to increase the efficiency of their operations, an activity defined as ***refining*** entrepreneurship.[7] An integrated framework combining catalytic, allocating, and refining entrepreneurship was first introduced in 1990.[8]

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These three types of entrepreneurs can be juxtaposed to the Kirton model of adaptive/inventive thinking, as shown in Figure 1.[9] The Kirton scale is along the horizontal axis and indicates comparative degrees of preference for adaptive or inventive thinking. Thus, moving toward the left, we find ***adaptive*** entrepreneurs who are involved in businesses with comparatively low risk; they solve problems in tried and understood ways by "doing things better." They manage change incrementally, work within the system, and implement the inventions of others; they supply stability, order, and organization. Conversely, moving to the right on the scale, we find ***inventive*** entrepreneurs who "discover" problems and originate creative ideas and innovative solutions; they question assumptions and take risks; they are "doing things differently." They provide strategic vision and create the dynamics to bring about radical change through break-through ideas. They are typically impatient with routine and detail and are seen as chaotic and abrasive, with little respect for rules. Inventive entrepreneurs need adaptive managers or team members to help them turn their ideas into a profitable business. According to Art Fry (inventor of the Post-it notes), CEOs and managers of established businesses typically want to keep the status quo by "doing things the same way." Also, Art Fry found that the relative distribution between the degrees of adaptive or inventive thinking seems to follow a standard Bell curve.

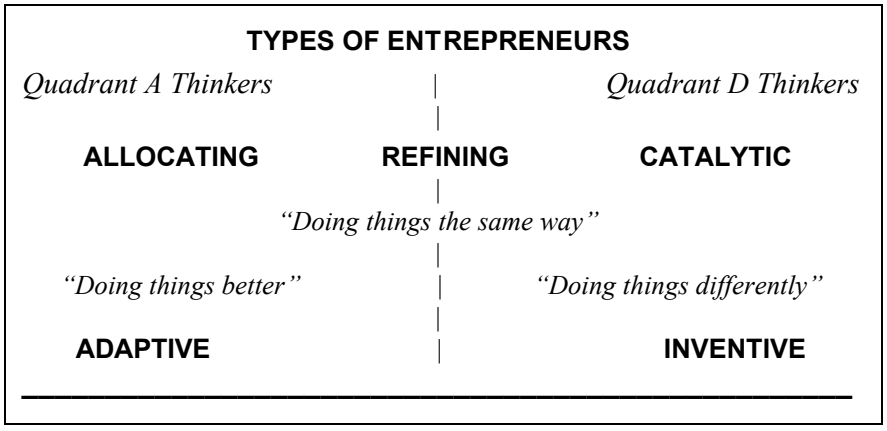


Figure 1 Different types of entrepreneurs and entrepreneurial managers

Engineering education stresses adaptive thinking; thus engineers become very good at solving given problems in routine ways. They are not usually encouraged to explore innovative solutions and identify customer needs and market niches using lateral thinking skills that can lead to break-through ideas and innovation and subsequently to a successful business. However, these skills can be taught to engineering students and at the same time serve as strong motivators. Also, student feedback has shown that the majority value the insight gained into thinking styles for personal development and from working on project teams that were purposely put together to maximize a diversity of thinking styles to achieve optimal project results.

Course objectives and description

The main objectives of the basic course in entrepreneurship developed by the authors are:

1. To provide an understanding of the principles and concepts of entrepreneurship and why it is now regarded as central to the efficient functioning of a modern economy.
2. To provide an understanding of product development and the steps and resources needed for business startup.

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3. To provide an understanding of the thinking and problem solving skills required for successful entrepreneurship, organized in the most effective sequence.
4. To provide immediate hands-on application in a diverse team project to enhance learning, with the project topic to be selected by the teams and the outcome resulting in the ability to generate a viable business plan.

Table 1 gives a summary of the most current course content taught in the Nottingham University Business School as a one-week, 35-hour intensive short course.

Table 1 Entrepreneurship course syllabus

Part 1:	**Introduction to entrepreneurship in the 21st century**
1	Course introduction and objectives; diagnostic activities; definitions.
2	Entrepreneurship as an area of study—the big picture and benefits. Motivational quiz.
3	The historical context and theories of entrepreneurship from 1700-2000.
4	Towards a synthesis—catalytic, allocating, and refining entrepreneurship.
Part 2:	**Creative thinking and creative problem solving**
5	The Herrmann model of brain dominance. Confidential HBDI results.
6	Implications of the HBDI for communications, teamwork and entrepreneurship.
7	Overcoming barriers and mental blocks to creative thinking. Lateral thinking exercises.
8	Overview of the creative problem-solving model. Problem definition.
9	Idea generation and creative idea evaluation. Inventive thinking exercises.
10	Critical idea judgment. Hidden assumptions. Solution implementation.
11	The Pugh method for developing optimized solutions. How to identify a problem/need.
12	Joel Barker video on paradigms.
Part 3:	**Team project application: How to be a creative entrepreneur**
13	Teams select a problem. Customer survey/research. Problem definition statement.
14	Creative thinking warm-up exercise. Teams brainstorm ideas for their problem.
15	Teams improve their creative ideas and develop concepts for the Pugh evaluation.
16	Pugh method Round 1 evaluation.
17	Round 2 evaluations of concepts using criteria that consider economics and marketing. Based on Round 2 results, teams choose their "best" concept for further development.
18	Project documentation. The 30-second "elevator pitch." Tips for effective team presentations.
Part 4:	**Entrepreneurship in action: Just-in-time topics/learning (concurrent with Part 3)**
19	Creativity, invention and innovation—what makes an innovative organization?
20	Protecting an invention; intellectual property/patents. How to do a patent search.
21	Useful web sites. Screening ideas. Evaluating market and innovation potential/opportunities.
22	Development, manufacturing, and marketing costs; researching your competition.
23	Risk analysis and resource requirements. Prototyping.
24	Business formats: sole proprietorship; partnership, corporation, franchise.
25	Licensing and selling an invention to a big corporation.
26	Trademarks; business name, logo, creative product name.
27	Assessment of profit potential; marketing plan.
28	Startup funding: internal financing; external financing. Looking beyond startup.
29	How to write a business plan.
Part 5:	**Assessment of learning**
30-34	Teams prepare and present a 20-minute team project presentation, including visual aids.
35	Feedback on presentations; course evaluation; final Q&A; written report/exam requirements.

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Early versions of the course were taught in different formats,[10] and the material ultimately crystallized into an easy-to-read 200-page paperback book.[9] A 70-hour version for a charter high school is now under development. Experiments were done with a one-credit-hour course as part of a university enterprise program, but the results make it difficult to recommend such a cursory treatment—students are conditioned to not take anything earning only one credit hour seriously.

Teaching approach

Prior to the start of the course, students are required to complete the Herrmann Brain Dominance Instrument (HBDI).[2] The confidential results are returned to them in one of the early sessions of the class. The results have a number of benefits:

- The instructors gain insight into the thinking preferences of the class as a whole and can tailor their presentations accordingly to increase learning.
- Students are put into 5-member teams by the HBDI evaluator, where the diversity of each team is maximized (as to educational background, working experience, and thinking preference), and ensuring that preferences in all thinking styles are present in each team.
- Students gain insight into their thinking preferences for self development; and they are able to make connections that increase their communication and teamwork skills (especially as they see the model in action in their diverse teams).
- Students can relate their thinking preferences to the type of entrepreneurship that would form a good match—it thus encourages them to explore these options and serves as a great motivator for learning in the course.
- Students learn where they need to make a special effort to increase the chances of success by not leaving out key steps in the product development and business startup process that may involve less preferred ways of thinking.

The course taught in Singapore is a required course—the last in their MBA program. The course taught in Kuala Lumpur, on the other hand, is an optional course in the MBA program. Almost all these students have full-time jobs, many of them at the managerial level, *and from one-fifth to one-half of the students in these classes are engineers by training* (although some are now working in managerial positions). Table 2 summarizes the average HBDI results for the five classes taught. For comparison, one class of 15 mostly engineering senior/graduate students at Michigan Tech had an average HBDI profile of A = 87, B = 73, C=52, D=79. Figure 2 describes the thinking modes included in each quadrant of the model (see also www.hbdi.com for additional information). An average in C of less than 50 is typical for engineering faculty and graduating engineering students.[3] Engineering faculty, on the average, tend to be higher in A (= 100) and lower in D (= 70) than these students interested in entrepreneurship.

Table 2 Average HBDI profile of entrepreneurship students

Class	*# HBDIs*	*Quadrant A*	*Quadrant B*	*Quadrant C*	*Quadrant D*
Singapore, Nov. 2000	35	87	75	59	68
Kuala Lumpur, July 2001	40	81	87	64	61
Singapore, Nov. 2001	41	84	75	63	64
Kuala Lumpur, July 2002	41	82	81	63	63
Singapore, Nov. 2002	42	86	81	58	68

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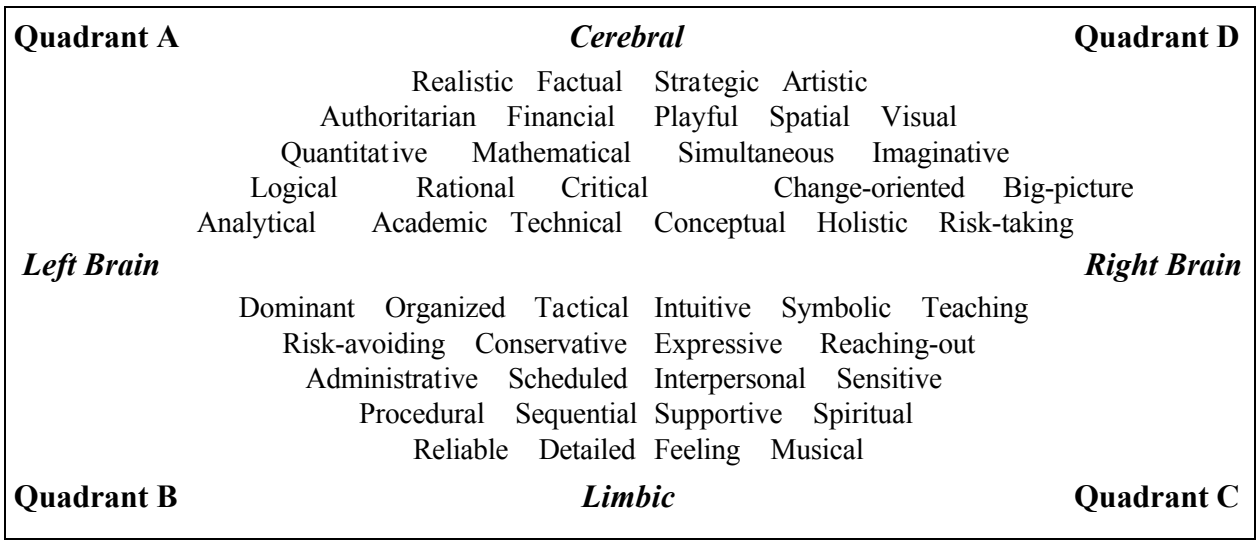


Figure 2 Thinking characteristics and behavioral clues of the Herrmann model[9]

The teaching methods used vary from lectures and theory (quadrant A) and step-by-step procedures (quadrant B) to hands-on teamwork/personal motivation (quadrant C) and metaphorical/conceptual/big picture thinking (quadrant D) and thus constitute a whole-brain approach. Students come to understand the rationale for learning to think and communicate in unfamiliar (and thus initially uncomfortable) modes. Early on in the course most students are startled to discover how conditioned they are to finding "only one right answer" instead of looking for many different, innovative ideas. Thus exercises in lateral thinking are an important part of the in-class activities during the first two parts of the course. Also, the creative problem solving process with the different mindsets associated with each step incorporates several iterative cycles of left-brain and right-brain thinking.[4,9]

Another important feature to reinforce learning is the team project, with each team identifying problem areas, customer needs, market niches, and then narrowing the list down to one topic for their team project. The teams are required to take their project through all the steps of the creative problem-solving model to develop a final concept or product. Then they have to prepare a team presentation on their final result (which has to incorporate aspects of at least a rudimentary business plan as appropriate to their topic—or other appropriate aspects of their learning, including an "elevator pitch"). There is a noticeable difference in the team project presentations between those at the end of a one-week intensive course and at the end of a semester course due to the different time frames. When students have more time, they will try to get their project to the prototype stage—which makes their presentations more interesting. However, even for the one-week courses, student teams will work very hard to get a high mark for their presentation, and they are proud of what they have achieved in such a short time.

Marketing—example of how one topic is integrated into the fabric of the course
Students are encouraged right from the beginning to consider customer needs and potential market niches when they brainstorm ideas for a team project topic. As they develop and refine concepts for the Pugh method evaluation, they need to conduct market research/analysis concurrent with invention, design and product development. They obtain information through

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literature and web searches, as well as from customer surveys and questionnaires that guide their market investigation. As their ideas crystallize into a marketable product, they are also encouraged to consider using a commercial assessment tool. Two maxims guide this process:

Know yourself! Know your product! Know your competition!

This information is available from the HBDI assessment, from the Pugh method process and results (which includes required cost, risk and feasibility analyses), and from the market research and analysis. The Pugh method is a valuable tool for discovering weaknesses in concepts. Investigating the competition is a key component of market research (and this includes patent searching), and it feeds directly into the improvement process of the Pugh method.

A product's selling price should be three to five times manufacturing cost to yield a profit!

It is interesting how this simple "rule of thumb" first surprises many students and then spurs them on to improve their designs and inventions to make them truly competitive and marketable.

For their products to have market value, students need to determine:

- Will the invention (product or process) work as intended? (That's where a prototype or pilot application becomes crucial.)
- What is the competition? If there is no competition, BEWARE!
- Is there a need for this product? If not, how could you create a need?
- What future changes, trends, or sudden paradigm shifts could affect demand for the product?
- Does the new concept perform a task that has not been achieved before, or can it do it faster, better, easier, or at substantially lower cost? From the Pugh method evaluations, students gain a clear idea of the customer benefits.

Guidelines for developing a marketing plan and marketing strategies are found at the SBA website, www.sba.gov/starting/indexbusplans.html, and some of the questions are condensed in the course into short tables that students can use to guide their thinking.[9] Sample questions are:

- Who are your customers—private sector, wholesalers, retailers, government, or other, and what is the percent distribution of each?
- What is the target industry and geographic area?
- How much is the selected market likely to spend on your type of product this year?
- Who are your competitors? List each main competitor by name, how long in business, the market share, the price and strategy, and the distinct product/service features.
- List your strengths and weaknesses compared to your competitors (consider location, size of resources, services, personnel, not just your product alone).
- What legal and government factors could affect your market? What are other environmental factors that could affect you?
- What economic factors over which you have little or no control could affect your product or service, such as industry health, economic trends, taxes, or rising energy prices?

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Learning outcomes

Due to the time constraints of the MBA courses in the one-week intensive format, some of the projects are by necessity rather "hypothetical." Thus, the students are required to write a learning assessment and submit this evaluation six weeks later. The major focus of the assessment is a mini case study where they have to describe an application of class learning either at home (personal life) or at work (professional life)—some examples are given in Table 3.

Table 3 Sample of case study topics and results (Malaysia 2002 MBA students)

Internet access—faster and greater access to Internet to enhance efficiency in a company's knowledge creation. Result: with calculated cost savings for the "best" option, management became convinced that their information technology infrastructure needed to be upgraded.
Introducing creative problem solving model to a work team of six. Result: team became convinced when the model was used to improve the efficiency of operations. Best concept was a tailor-made computer program; this was implemented in a pilot for the ordering and invoicing system (10% of operations). After 4 weeks, system tested out and demonstrated a high level of efficiency; thus the team is proceeding to other components of operation.
Improved design of work platform. Result: "best" design solved many problems and workers are looking forward to test out the prototype.
Getting kids to school on time. Result: this student's "best" solution concept was to restructure the family's evening activities (by swimming and grocery shopping); thus the kids went to bed earlier in a relaxed mood, were awake earlier and ready for school, and mom's day went more smoothly since food shopping did not have to be done in the morning.
Dissatisfaction with new condo/apartment. Result: the "real" problem was identified and a "best" solution developed and implemented which made this young couple much more satisfied with their investment.
Teaching children creative problem solving through a personal application. Result: this father achieved two goals—teaching his children the problem solving process and getting them enthusiastic about his hobby of beautifying the family home with a flower garden.

The important goal was not to achieve a spectacular concept but to apply and experience the benefits of the creative problem solving model learned in the course. With the exception of two students, all demonstrated through the mini case study that they understood the model, were able to employ it correctly, and were convinced that the model worked and was useful in their lives for obtaining optimal solutions to problems. Here is one of the outstanding results described by one of the students, a development manager in a life insurance company:

> *"Entrepreneurship does not necessarily mean a person venturing to set up his or her own company and selling a unique product or service to people who desire it. Entrepreneurship can also refer to those who handle daily responsibilities in an organization. Hence my goal in entrepreneurship is to be able to execute my daily responsibilities in a manner that is consistent with the spirit of creativity, innovation and ingenuity. When I applied what I learned in the class in my company, our income over five weeks increased by 400 million Singapore dollars."*

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Finally, as part of their learning assessment, the students also had to indicate their future plans for entrepreneurship in a one-page essay. Table 4 gives a representative sample. About 40 percent of the students had no specific plans for entrepreneurship but found the thinking skills gained in the course useful in their present occupations. About sixty percent of the students are either already involved in entrepreneurship or are seriously thinking about starting a company.

Table 4 Entrepreneurship plans of Malaysia 2002 MBA students

No direct plans, but found thinking skills/knowledge gained useful:

1. Student works regularly with entrepreneurs; course helped in understanding their mindsets.
2. Entrepreneurship class was a real challenge, but opened her mind. She does not rule out becoming an entrepreneur in the far future.
3. Student is helping her husband in his business; the learning has been useful.
4. Student's family had a negative experience with entrepreneurship; student has gained a more positive outlook from course on how to use failure as a steppingstone to success.
5. Student is using learning to increase her job performance in current position.
6. Student did not think she had capabilities, but has gained confidence that she could succeed; she will first apply the skills learned in present job before starting a new enterprise.
7. Student is applying tools learned in her company where she is manager.
8. Student found that course provided skills to stay one step ahead in global economy.
9. Learning is useful in present job for remaining competitive in the international market.
10. Student will apply course learning to nurture entrepreneurial creativity in his organization.

Near-term entrepreneurship applications:

1. After retiring from government service and earning MBA, the student will first do the franchising route; found knowing traits of entrepreneurs especially valuable.
2. Student wants to start interior decorating business; course learning helps in planning it.
3. Student identified a potential niche market in class; wants to start up this business soon.
4. Student (already an entrepreneur) wants to make her company more innovative.
5. Student is excited about becoming an entrepreneur and is presently preparing for financial independence. He is already developing ideas and looking for a suitable partner.
6. Student wants to invent a new product to help his company improve market position. His former employer lost out to a competitor by not patenting a product the student invented.
7. Student realized that he has been working in the wrong field; he thus wants to switch as soon as possible from sales management to starting a consulting business.
8. Student wants to start an entrepreneurship education and consulting company in his home city (Bangalore, India), so young people can create their own businesses and jobs.
9. Student expected a "recipe" for entrepreneurship but gained important thinking skills and an understanding of innovation. She wants to get into the fashion and cosmetics business.
10. Student wants to use course learning to start an IT consulting business.
11. Student wants to set up a unique coffee house with an innovative-thinking partner.
12. After obtaining MBA, student wants to start his own company with a radically different environment. Also, he will do his MBA dissertation in the area of entrepreneurship.
13. Student wants to learn more about finance and then start with franchise, followed by starting up an innovative company.

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It is difficult to design a quantitative assessment for this type of a course that goes beyond the format of a typical exam which mostly gives a measure of the quadrant A knowledge that students are able to regurgitate at that moment and does not indicate anything about the students' ability to apply this knowledge in the real world. Student feedback has been a crucial part of the assessment and has been invaluable for improving the course and the materials from year to year.

One of the authors (Lumsdaine) has tried to teach portions of the entrepreneurship syllabus as one-credit-hour modules as part of an enterprise program. However, the results are not very satisfactory—there is a noticeable lack of motivation and coherence, with the conclusion that it is not possible to teach the thinking model, the team processes, conceptual design principles and the creative problem solving model as disjointed units (one per term) and then expect the students to put them all together in a project at some point down the line, with entrepreneurship thrown in with an occasional lecture. Frankly speaking, such an approach is a waste of time (the professor's time as well as the students' time).

The other author (Binks) has taught a modified version of this course to undergraduate students at the University of Nottingham in a ten-credit "Entrepreneurship and Business" module. The course has been adapted for larger numbers by using mentored group work and individual group '"lab sessions" to ensure that each step of the creative problem solving process is fully applied. With virtually no marketing, the course of eleven one-hour sessions delivered weekly throughout the second semester attracted 95 students in 2002 and 187 in 2003. The course is delivered in tracks with a maximum of 100 students per session. *It has now been adopted as a core course in engineering*. Numbers are expected to more than double over the next two years. Students are assessed on the basis of a poster presentation and "elevator pitch" to a mix of academics, venture capitalists and industrialists (35%). There is also a two-hour examination (65% of course grade).

The assessment process is particularly challenging in courses of this kind. It is important to use a mixture of assessment procedures in order to evaluate the impact and outcomes of very different kinds of projects and also to ensure that students are appropriately motivated. Experience to date suggests that high levels of significance should be attached to performance in terms of creativity, organization and presentation by evaluating the students both in their groups and individually. The combination of group presentation with the requirements for coordination and collaboration as well as creativity and imagination is well complemented by individual and reflective coursework on the nature of the student's experience. Examinations can also be used to give individual students an opportunity for critical reflection on the course experience and its potential for further improvement (as has been done in the courses taught through the University of Nottingham Business School). The inclusion of an examination may also serve to reassure some university academics as to the rigor of the course and its assessment procedures! The examination questions almost exclusively elicit essay-type responses calling for higher-level critical thinking and evaluation skills.

The following excerpt is from a letter received recently from a student in the pilot invention and entrepreneurship class taught during Fall 1999 at Michigan Tech[10] and shows that a three-credit-hour course can have a lasting impact. The student began working for Ford Motor Company a year later.

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"Of the 244 credits I earned throughout my undergraduate education, your invention and entrepreneurship class has without a doubt been the most important influence in my engineering career. My future plans include running my own business, and I feel that your class was the only one offering any insight to that path."

Recommendations

Based on the experiences with the courses described in the paper, as well as other creative problem solving, design, and invention classes taught by the authors,[10] the following factors and conclusions are deemed important for effective learning, an effective academic program, or a successful entrepreneurial outcome for engineering students:

- Sufficient time must be allocated for an entrepreneurship course. Although a one-week intensive course is suitable for MBA students (who can often apply the learning immediately in their work environments), undergraduates need time to assimilate the material. When they get excited about their product or invention, they will spend an extraordinary amount of time and effort in developing their idea (which can have a negative impact on their other courses), unless they are given an adequate amount of time (with space for teamwork) and possibly some financial support for prototype development. Learning the "theory" or principles without an immediate application in an interesting project is more or less a waste of time.
- Engineering students need guidance in how to "find" or "discover" problems that have market potential, and they also need guidance in looking at their product or design from the customer's point of view. Many engineering professors are not used to looking beyond finding a technical solution to a problem; thus students are not usually encouraged to look at marketability or entrepreneurship in their regular curriculum.
- To increase the perceived "value" of an entrepreneurship course and gauge a student's motivation, students could be interviewed before accepting them into such a class, just as if they would be hired into a company or a work team—in essence, the ultimate goal of such a course would be for student teams to launch their own enterprises, and students need an up-front reminder of this purpose (and the team effort that will be required).
- The teaching approach should initially be geared to the engineering "culture" for early comfort, but then new thinking modes need to be introduced to make students adaptable to the thinking required for entrepreneurship.
- Support by the academic administration and faculty peers is needed—there must be a climate that makes innovation and creative thinking (and entrepreneurial research and multidisciplinary projects) not only acceptable but also recognized and rewarded.
- The age and maturity of the students is not as important as adapting the material to their level, as long as it is presented interactively to their learning styles.
- In Europe and the Far East, students are much more aware of international economic competition and its impact on their personal careers and lives. US students, in comparison, are often very narrowly focused on an immediate "engineering" problem only, and they need encouragement to think in broader terms and look at global opportunities.

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