A Model of Entrepreneurship Education for Computer Science and Computer Engineering Students

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Abstract – **Creativity and innovativeness are among the most essential attributes of engineering graduates and also of successful entrepreneurs. Entrepreneurship, or the process of starting a new venture, is one of the main roads to new technological innovations. This paper presents two novel models of entrepreneurship education integrated in computer science and computer engineering curricula and geared towards computing students with entrepreneurial intentions. To expose all computing students to entrepreneurial ideas and to spark their entrepreneurial spirit, we also developed several entrepreneurship add-on modules for existing CS and CE disciplines. All these programs have been developed and implemented at Hofstra University, with modules implemented also at Qatar University. Preliminary evaluation results are presented and discussed.**

Index Terms – computing entrepreneurship education, modules in entrepreneurship.

INTRODUCTION

Creativity, innovativeness and leadership are among the attributes of future engineers as identified in the "Engineer 2020" report by National Academy of Engineering. Entrepreneurship [1] is the process of starting a new business/product or service. The most common stages of an entrepreneurial cycle are: opportunity identification and evaluation, resource gathering, start-up phase and growth phase. Creativity and innovativeness are needed in all phases of the entrepreneurial cycle, but critical during opportunity identification, evaluation and start-up phases. Other characteristics, such as leadership, tenacity, confidence, ability to communicate vision and goals, ability to manage new resources and skills take central role in latter stages. Research on entrepreneurship has found that formal education and prior experience in entrepreneurship increases self-confidence in students in entrepreneurship, which in turn correlates well with entrepreneurial intentions [2]. Additionally, proactive and creative students report high-levels of entrepreneurial desirability and intentions [3]. Moreover, the computing industry is one of the most dynamic fields, penetrating many other areas. Thus, integrating entrepreneurship education and activities in computing curricula can have a significant effect on the creativity, innovativeness, leadership and entrepreneurial intentions of computing graduates.

Previous models of entrepreneurship education in engineering range from single upper–level courses in entrepreneurship engineering, minors or certificates in entrepreneurship, to holistic, integrative programs [4]-[6]. Most of the engineering entrepreneurship programs are either co-hosted by engineering departments and business schools or are offered entirely by business schools. Few entrepreneurship programs are aimed for CS or CE students.

The programs and activities developed in the CS department at Hofstra University and Qatar University that appear in this paper have the following novel characteristics: they expose students to innovation and entrepreneurship in computing, focus on computing industry, and provide hands-on entrepreneurial practices within a variety of computer science or computer engineering activities. They encompass breadth entrepreneurial activities and education for all computing students, as well as entrepreneurial educational experiences for entrepreneurial interested students.

DESCRIPTION OF COMPUTING ENTREPRENEURSHIP EDUCATION AT HOFSTRA UNIVERSITY

The computing entrepreneurship curricula developed in the Computer Science Department at Hofstra University consists of: (A) *The breadth component* composed of modules in entrepreneurship integrated in CS/CE technical courses throughout the four-year curricula, and seminars in entrepreneurship; and (B) *The depth component* composed of two novel programs in computing entrepreneurship. Both components are detailed below.

A) The breadth component

The breadth component exposes all CS/CE majors to entrepreneurial ideas and innovative ways of thinking. We developed add-on entrepreneurship modules in existing CS and CE courses, ranging from freshman to senior, required to elective courses. The goal of these modules is to expose all students to entrepreneurial ideas and activities in the context of a specific computing discipline. We already developed and implemented three modules in each of the following courses: data structures and algorithms, computer

ethics, and software engineering. They are described in the next section.

In addition to the entrepreneurship modules, the breadth component consists of seminars and talks given by local entrepreneurs, venture capitalists and patent lawyers. These talks range from personal entrepreneurial experiences, to lectures on intellectual property. They expose all students to entrepreneurial activities, insight and knowledge.

We expect students exposed to the *breadth component* to increase their awareness to innovation and creativity in high-technology computing areas and to enhance their ability to identify market needs and entrepreneurial opportunities in computing.

B) The depth component

The depth component targets CS and CE students with strong entrepreneurial intentions. It consists of two new programs called: Concentration in Leadership and Innovation in Computing (CLIC) and Option in Leadership and Innovation in Computing (OLIC). The novel features of both programs are: a focus on entrepreneurship in the context of the computing industry, and hands-on entrepreneurial experiences. They differ through the number of credits and the level of general business knowledge. The concentration is eighteen credits with four business courses offered by the business school, while the option is nine credits with no general business course. Both programs include the same hands-on entrepreneurial experience via an internship course with local entrepreneurs, and a year-long senior design entrepreneurial project. The programs are detailed in the section Entrepreneurship in computing programs.

The rationale for having two programs is due to the different nature of the CS and CE programs at Hofstra University: CE students have a high number of required credits and cannot take the additional eighteen credits in the concentration without extending their college education beyond four years. This situation is likely to be encountered at other institutions as well. Thus, the option is a good model of entrepreneurship education for computing degrees with a low number of free electives, while the concentration is closer to a minor.

Moreover, we want to assess whether the option can attract and retain more students than the concentration, thus testing the hypothesis that a shorter, more focused program (the option) is more desirable than a longer program with general business courses (the concentration).

The student learning outcomes for these programs include ability to:

- Identify and evaluate innovative business opportunities in the computing industry,
- Understand the process of starting and financing a new venture,
- Attain knowledge of intellectual property issues, and
- Acquire basic knowledge in financial accounting and marketing.

ENTREPRENEURSHIP MODULES IN CS/CE COURSES

In this section we detail the add-on entrepreneurship modules we developed for several required or elective courses in CS or CE. The modules were designed with the following general guidelines: no reduction in discipline specific material and integration with technical content and assignments of the class. After several discussions, we agreed that all modules should contain the following three elements:

- *A general introduction to entrepreneurship*: what it is, what it means to be an entrepreneur, what activities do entrepreneurs typically engage in.
- *A part related to the technical content of the course:* One or two related entrepreneurial computing business cases are presented in detail and discussed in class. Typically, the following issues are highlighted: How did the entrepreneurs come up with the idea? How did they implement it? How did the business grow? What business model was used? What hurdles were encountered and how were they overcome?
- *An assignment* in which students work on one or more entrepreneurial tasks such as identifying a new business opportunity in the course area, outlining a business plan, or managing the implementation of a project.

We plan to develop six entrepreneurship modules spanning required and elective courses in all four years of study, as follows: Data structures and algorithms (required, freshman), Introduction to computer architecture (required, sophomore), Computer graphics (elective, junior/senior), Computing, ethics and society (required, junior), Software engineering (required, senior), Computer gaming (elective, senior). So far, we have developed and implemented three modules described next.

1) Entrepreneurship module in Data Structures and Algorithms: The data structures and algorithms course is a second semester freshman course. We implemented the entrepreneurship module for the first time in the 2009 fall semester. The module consisted of the following in-class activities: (i) A 30-minute presentation about entrepreneurship and the stages of an entrepreneurial process (identifying and evaluating a new business opportunity, business plan, financing and start-up phases), (ii) A 50- minute DVD describing the history of Google and its creators, and (iii) a 30-minute discussion after the video, in which students identified the main human, societal and economic factors behind Google's success. Web search engines and Google were chosen as a business case example in the Data structures and algorithms course due to the relevance of ranking algorithms to the course. A take-home package included two handouts written by experienced local entrepreneurs on how to evaluate a new business idea and on how to write a business plan. A take-home assignment was developed to assess student's understanding of

entrepreneurial principles. The creative part of the assignment asked students to identify a new business opportunity either in the web search area or in another computing area. They had to evaluate the merits of their idea, in terms of its novelty, its potential market, and profitability. Students had to research the web for similar products or patents.

2) Entrepreneurship module in Software Engineering: We attempted a sandbox model for teaching entrepreneurship in a software engineering (SE) class at Hofstra in the 2009 fall semester. The model comes from the fact that some universities do not possess the same resources as the major research institutions, where many faculty research projects are available for technology transfer. The sandbox model uses a fixed term project topic to engage students and weaves the discussion of a variety of entrepreneurship topics in a collection of milestone projects. Each milestone project is prepared so that students could fail, but they can always resume from the next milestone. The use of sandbox approach is debatable -- a fixed project topic may limit the creativity of students. On the other hand, we argue for the effectiveness of the approach. One could achieve a good coverage of entrepreneurship topics without requiring extra room in the curriculum.

In the SE class, we focused on the "technical" aspects of entrepreneurship. In particular, we expect the students to be able to assess technical feasibility of business ideas, to make a simple budget plan based on complexity analysis, to make design decisions given business requirements, and to experience different roles in a virtual start-up environment.

The design of milestones centers around a term project on creating a cross-platform 2D bomber man game that we can deploy on prevalent desktop systems as well as portable computing devices (such as cell phones and PDAs). Students conduct a brief market research resulting in a business plan. They form several virtual start-up companies with four students on average. Each virtual company adopts a simple company structure, consisting of one CEO, one project leader, and three programmers/testers. The CEO is responsible for keeping track of all company financial data, e.g., the labor cost. The project leader is responsible for defining the sprint tasks (They adopt a SCRUM agile paradigm in the class). Programmers/testers bid for sprint tasks to "get paid." During the semester, students have to switch roles in each milestone, thus permitting one student to experience all the roles. It is quite usual for a group to fail a milestone due to a wide variety of causes ranging from technical difficulty to group management issues, such as some of the group members "change jobs" or simply quit in a milestone. During the semester, a series of nine milestones are used to cover topics such as: business idea assessment, virtual company organization, agile software engineering for start-ups, and business plan development. At the end of the semester, all virtual companies manage to finish a prototype of the bomber man game on the Windows platform using the Windows GDI and the 2D API of the DirectX. One student finished a 3D prototype of the game using XNA. According to the report documented at each stage, on average, the labor cost of the project is around 400 hours per virtual company.

3)Entrepreneurship module in Computing, Ethics and Society: Qatar University is one of the global institutions affiliated with this entrepreneurial project. The ethics course at Qatar University and at Hofstra University is a one-semester hour course. At Qatar, the ethics class is face-to-face with active use of virtual discussions; at Hofstra, the ethics class is totally distance learning. We have developed entrepreneurship modules involving computing ethics and applied them at Qatar and at Hofstra. At Qatar, students are predominantly of the Moslem faith and they derive their ethical behavior mostly through the teaching of the Holy Quran. At Hofstra, we would expect students to be of mixed cultural backgrounds without a specific cultural viewpoint.

The entrepreneurial modules used at Qatar were similar to those at Hofstra. One module used at both institutions was to have students read a WikiBook titled, "Getting Started as an Entrepreneur" [7]. The six chapters (with sections) used by the students are as follows.

- Opportunity (Entrepreneurship Is, Your Intellectual Property)
- Market (Identifying Your Customer, Evaluating the Market)
- Team (Networking, Profile: The Right Team)
- Plan (Business Plans, Tips and Tricks)
- Company (What Makes it a Company, For Profit or Not)
- Money (Bootstrapping, Your Equity Cycle)

The assignment had the following basic description:

> *Sometimes entrepreneurs use unethical or illegal tactics to achieve their goals. Assume you are the entrepreneur and you are opening a software business. Write a term paper contrasting possible business practices you might use that could be in conflict with the established norms founded upon professional and ethical principles.*

Students had to either write an essay on the topic or engage in a vigorous online debate to exchange opposing points of view. Whether essay or debate, students received a grade proportional to their ethical-business contrasts rather than their personal opinions. Pre- and post-surveys revealed that students had an elevated awareness of ethical vs. business practices. They also had gained some knowledge on becoming an entrepreneur and they were more willing to take prudent risks to achieve success.

It is interesting to note that students from Qatar often expressed their disdain for unethical practices in the business world and they based their reasons mostly on religious grounds. For example, during an in-class discussion on bribery and entrepreneurial advancement, almost all students condemned the practice of bribery because of religious beliefs while knowing that bribery is sometimes part of the business world. In contrast, students

at Hofstra who participated in an online discussion on bribery would make no implication toward religion to make their case for or against the practice of bribery.

Entrepreneurial discussions contrasted with ethical philosophies are revealing. They open students' minds regarding situations they might face in later years that could lead to unethical practice. Such awareness is important for those who aspire to become leaders and risk-takers in entrepreneurial ventures.

ENTREPRENEURSHIP IN COMPUTING PROGRAMS

In this section we describe the new programs in the depth component: Concentration in Leadership and Innovation (CLIC) and Option in Leadership and Innovation (OLIC). Both programs target students: who aspire to affect society with innovative ideas in the computing field, who want to work in dynamic and innovative environments, or who seek to expand their knowledge on entrepreneurship and business functions in the computing industry.

They began being offered in the 2009 fall semester. Their content is as follows:

- *Concentration in Leadership and Innovation (CLIC):* The concentration program has 18 credits, twelve offered by the School of Business and six by the CS department. The four business courses are: Entrepreneurship, Financial accounting, New business ventures and Marketing. The CS courses are: internship with an entrepreneur, and a year-long senior design of an entrepreneurial project. The concentration is similar in number of credits to a minor, but it is made up of courses offered by two departments. To make the business courses more relevant to computing students two of them (Entrepreneurship and New business venture) contain specially designed modules with material and assignments relevant to the computing industry.
- *Option in Leadership and Innovation (OLIC):* The option program has 9 credits all offered by the CS department. It consists of a new course called: Foundations in leadership and innovation in computing (FLIC) – detailed below, and two courses shared with the concentration: internship with an entrepreneur, and senior design of an entrepreneurial project.

Both CLIC and OLIC share the principle that the business knowledge acquired in courses must be experienced: both, in a start-up environment under the guidance and mentorship of an entrepreneur (the internship with an entrepreneur course), and in the senior design project, where students implement the technical part of their innovative business idea.

The main differences between the concentration and the option are the number of credits, the depth of coverage of general business courses such as Financial Accounting and Marketing, and the integration with the computing industry. They also represent two different models of computing entrepreneurship education: The concentration that fits institutions with a business school and with flexible degree requirements that allow the addition of at least 12 credits for the business courses. The option is suited more to institutions without a business school and/or degree requirements that do not allow students to take extra credits without going staying beyond the four-years of study. At Hofstra, the concentration suits more CS students, while the option is better for CE students.

By developing the two programs, we also want to test the hypothesis that the option as a shorter, more focused program can attract and retain more computing students than the concentration. This idea is based on feedback received from other institutions, which experienced a low retention rate in entrepreneurship minors with many general business courses. The reason cited was that students felt disengaged and lost in general business courses, and thus lost interest and quit the program after a few courses. On the other side, a shorter program should not imply less preparation for an entrepreneurial career, only a more applied and more integrated entrepreneurial and computing education. The new course, FLIC, aims at providing the entrepreneurial knowledge applied to the computing industry. Our assumption is that one course in which students learn only the business aspects needed to evaluate a computing business opportunity, to start a new venture, to understand intellectual property, financial and legal aspects and apply them repeatedly to ideas in the computing field is enough to prepare them for an entrepreneurial career, while also keeping them motivated. The FLIC course is described next.

An experienced local entrepreneur developed the FLIC course and the department offered it for the first time in the 2010 spring semester. The goal of the course is to expose students to a complementary view of computer science and computer engineering, namely that of innovation in high-technology computing area. The course prepares students to work in a competitive environment and gives them the mind-set and knowledge to search for new problems and innovative solutions. During the course, students interact with entrepreneurs in the computing field, gain hands-on experience on identifying and evaluating new business opportunities, developing business plans, drafting contracts, learning how to negotiate, how to handle intellectual property issues, and how to assess the financial needs and prospects of a new business. As final project, students develop a comprehensive business plan for their own idea in the computing industry. Then, they present their business ideas and plans to a judge panel formed by local entrepreneurs during an annual Computing Entrepreneurship event. The most valuable ideas are awarded.

The senior design entrepreneurial project is also a new course developed for the two computing entrepreneurship programs. It is a year-long three-credit course composed of two components in each semester: a seminar course of 0.5 credits and an independent course of 1 credit. The goal of

the seminar course is to provide a forum where all students in the concentration or the option meet and exchange ideas on their projects, make presentations, obtain feedback, attend seminars by entrepreneurs. In the independent course, students meet weekly with a faculty advisor who advises them on the technical aspects of the project. All students in the senior design entrepreneurial project have the option to work with senior students from universities abroad and, thus to experience the challenges and opportunities of a global working environment. Currently, we have ongoing collaborations with universities from Romania, Qatar and China. This course differs from regular senior design classes through its requirement to work on an entrepreneurial, innovative idea, justified and evaluated by a business plan.

The internship with an entrepreneur course consists of a semester long hands-on experience in a local small computing company or start-up under the guidance and mentorship of an experienced entrepreneur. This course differs than regular internship courses, through its experience that must include all aspects of the business: financial, marketing, management, and technical.

RESULTS

The depth component started in the 2009 fall semester, while the breadth component started in the 2008 fall semester. During the 2008-2009 academic year we organized the following activities:

- Five seminars were presented by several entrepreneurs, a venture capitalist and a patent lawyer. The goal of the seminars was to increase students' awareness and interest to computing entrepreneurship.
- In May 2009, we organized the first Computing Entrepreneurship Evening. Students presented posters with their class or senior design projects to local entrepreneurs.
- The E-Advisory Board was formed to advise on the Computing Entrepreneurship option and concentration programs.
- The entrepreneurship in computing module was implemented for the first time in the Computing, Ethics and Society course both at Hofstra and at Qatar University.
- A senior CE student worked on an entrepreneurial project with a team of students from Stony Brook University and from Romania. The project and the experience of a global E-Team are described in [8].

The impact of these activities was assessed by means of surveys and interviews conducted by two external evaluators. The results are analyzed in [9]. In summary, it showed that before any exposure to entrepreneurial seminars, the majority of computing students at Hofstra have a weak understanding of entrepreneurship, with more than a third expressing a strong interest in learning more, and more than half expressing some interest in learning more [9]. The conclusion from these initial surveys was that a significant number of our students are interested in learning more about entrepreneurship.

During the 2009 fall semester, the three entrepreneurship modules developed so far were implemented. Surveys were taken at the beginning (pre-surveys) and at the end of each class (post-surveys). Table 1 contains all survey questions. Questions 1 to 9 are answered on a 5-point scale from: 5 (Agree Strongly) to 1 (Disagree Strongly), while questions 10 to 14 require open answer.

TABLE I
SURVEY QUESTIONS

#	Question	Type
1.	I have a good understanding of entrepreneurship.	1-5
2.	I have strong interests in entrepreneurial activities.	1-5
3.	I understand what it takes to be an entrepreneur.	1-5
4.	I know people who have started their own businesses.	1-5
5.	I plan to start my own business some day.	1-5
6.	I know what it means to file a patent.	1-5
7.	I know what intellectual property means.	1-5
8.	I would like to learn more about entrepreneurship.	1-5
9.	I would like to start a computing company some day.	1-5
10	If you were to start a technical business, what would be your first step?	Open
11	What are some characteristics needed by an entrepreneur?	Open
12	What is the difference between a start-up business and a corporate business?	Open
13	How is a start-up financed?	Open
14	What are intellectual property rights?	Open

Table II contains the results of the pre- and post-surveys for the first 9 questions in the three courses. DSA stands for the Data structures and algorithms, SE for Software engineering and CES for Computing, ethics and society. DSA and SE were taught at Hofstra University, while the CES course was taught at Qatar University. Each number represents the percentage of responses in the 4-5 scale range. The last row (M) contains the average per each column. The number of students taking the survey is shown in parentheses in the table header. The number of students in the DSA and SE courses is relatively small to draw any significant conclusions. In all, but the SE course, students report an increase in entrepreneurial understanding. In SE and DSA courses the number of students interested in entrepreneurial activities decreased slightly after exposure to the entrepreneurial module (question 2). Also, the percentage of students who plan to start a business (question 5) dropped for all three courses. The pre-survey percentages for question 5 in SE and CES courses are over 80%, which is a bit unrealistic. Also students' interest in learning more about entrepreneurship (question 8) does not change significantly for any module. One hypothesis for these

results is that with more understanding of entrepreneurship there is a decrease in one's self-confidence to pursue it. In the CES Qatar course, a different attitude was observed: students showed a positive reaction to the module by increasing their interest and knowledge in entrepreneurial activities. They also report lower initial levels of understanding of what it means to be an entrepreneur (29%).

TABLE II
RESULTS OF PRE- AND POST-SURVEYS

#	DSA Pre (13)	DSA Post (12)	SE Pre (8)	SE Post (10)	CES Pre (24)	CES Post (19)
1	54	75	57	40	29	95
2	69	58	71	60	67	74
3	46	58	67	50	33	79
4	62	75	100	70	63	63
5	46	33	86	50	88	79
6	75	58	71	80	18	74
7	62	58	100	90	42	74
8	62	67	71	70	88	72
9	46	25	57	70	71	79
M	58	56	75	64	55	76

Compared to last years survey results, where students were exposed only to seminars, the percentages for questions 1 and 2 increased by 15%. Also, students in the more advanced classes (SE and CES) show a better understanding of intellectual property issues than those in the freshman class (DSA).

In the spring 2010 semester, the FLIC course was taken by 12 students. The course ended with the Computing Entrepreneurship Competition where students presented and defended their business ideas in front of a judge panel. All students expressed enthusiasm for the course content and for what they have learned.

CONCLUSIONS

The paper presents a new model of entrepreneurial education in computer science and computer engineering curricula. It consists of two components: (1) The breadth component aimed at exposing all students to what it means to be an entrepreneur in a computing area through seminars and entrepreneurship modules in several CS or CE courses; and (2) The depth component composed of two programs in computing entrepreneurship, the option and the concentration which target students who aspire to become entrepreneurs and who need a more detailed coverage of the business and financial aspects.

Survey results from the first offering of three entrepreneurship modules show mixed results with a trend in decreasing interest in entrepreneurial intentions, but increase in learning more about it. Students from Hofstra and Qatar University were affected differently by the entrepreneurship modules, though in different courses. We plan on assessing the effect of the CES module at Hofstra, and to compare it with that at Qatar University.

In future work, we will evaluate the two programs in computing entrepreneurship, just launched in the 2009 fall semester, develop at least three more entrepreneurship modules, and further improve the existing ones.

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REFERENCES

[1] National Academy of Engineering, "The Engineer of 2020: Visions of Engineering in the New Century", 2004, ISBN-10: 0-309-09162-4.
[2] Zhao, H, Seibert, S, E, Hills, G, E, "The mediating role of self-efficacy in the development of entrepreneurial intentions", *Journal of Applied Psychology*, Vol. 90, No. 6, 2005, pp. 1265-1272.
[3] Zampetakis, L, A, "The role of creativity and proactivity on perceived entrepreneurial desirability", *Journal of Thinking Skills and Creativity*, Vol. 3, 2008, pp. 154-162.
[4] Stanford Technology Venture Program, http://stvp.stanford.edu.
[5] Wisel, J,C, Rzasa, S,E, "Institutionalizing the assessment of engineering entrepreneurship", *34th ASEE/IEEE Frontiers in Education Conference*, 2004.
[6] D'Cruz, C, O'Neal, T, "Integration of technology incubator programs with academic entrepreneurship curriculum", *Management of Engineering and Technology, 2003. PICMET Technology Management for Reshaping the World. Portland International Conference*, 2003, pp. 327 – 332.
[7] http://en.wikibooks.org/wiki/Getting_Started_as_an_Entrepreneur.
[8] Doboli, A, Doboli, S, Currie, E, H, "Preparing Computer Engineers for a Global Economy: A Study on Effective Collaboration Practices in Global Student Teams", *In Proceedings of Frontiers in Education Conference*, Austin, 2009.
[9] Tang, W, Doboli, S, Gafney, L, Lowes, S, "Project EXCE2L (Excellence in Computer Education with Entrepreneurship and Leadership Skills): A work in progress to revitalize undergraduate computing curriculum through entrepreneurships", *In Proceedings of the 2009 International Conference on Frontiers in Education: Computer Science & Computer Engineering, FECS 2009*, July 13-16, 2009, Las Vegas Nevada, CSREA Press 2009, pp. 325-330.

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