



A multi-pronged approach to nurturing IT entrepreneurs

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A Multi-Pronged Approach to Nurturing IT Entrepreneurs

Abstract

Interest in engineering entrepreneurship has grown dramatically over the last few years. This is not surprising given the potential rewards of a successful entrepreneurial career both with respect to allowing entrepreneurs the freedom to pursue their own ideas and visions as well as with respect to the potential for large material rewards. But how do we nurture students to become successful entrepreneurs? In this paper, we report on an innovative program at the authors' institution, designed to nurture students to become IT entrepreneurs. While the program builds on the experiences of other programs, it includes a number of novel components that are integrated together in an unusual manner to interlock and complement each other.

1. Introduction

It is widely accepted that entrepreneurship is the engine that drives the American economy, indeed, even the world economy. This has become truer than ever in the last several years with the collapse of some traditional industries. By contrast, many new industries, especially ones created by *information technology (IT) entrepreneurs*, have flourished in ways that one would not have dreamed of even a few short years ago. Companies created by entrepreneurs pursuing novel technical visions and with the business savvy to implement them have not only been extremely successful commercially but also have had an enormous social and cultural impact changing the way we work, live, and play, and even leading social revolutions. Moreover, the tools and technologies created by several of these companies have enabled an ever growing number and variety of enterprises in many different engineering domains.

Not surprisingly, there has been a sharp increase in the number of engineering students, including especially those in computing-related majors, interested in becoming entrepreneurs. How do we nurture these students to become successful entrepreneurs? In this paper, we report on *NEWPATH*, an innovative program at the Ohio State University, designed to develop answers to this question. While the program builds on the experiences of other programs, it includes a number of novel components that are integrated together in an unusual manner to interlock and complement each other. As we detail in the paper, the result is an ecosystem that is very effective in achieving its key goal of helping nurture future IT entrepreneurs.

Over the last several years, researchers have developed various models of learning that attempt to identify particular factors that play key roles in helping students learn in different disciplines, including especially STEM disciplines. These have ranged from *constructionism*^{1,2} which is based on the idea that effective learning is most likely when an integral part of the learning activity is having the learner construct a meaningful product; to *collaborative learning*^{3,4,5} and the *community of inquiry* model^{6,7}, which argues that constructionism must be complemented by collaborative learning in order to be truly effective; to the broader *how people learn* framework⁸. *Internships*

and other experiential activities that are common to many of the engineering entrepreneurship programs, and are also a key part of NEWPATH, may be considered to be the constructivist components of these programs. But, as hinted above and as we will see in detail later in the paper, NEWPATH is unique with respect to a number of other components and with respect to an *integrative* component that not only enables but actively promotes collaborative learning in a community-of-inquiry setting.

Standish-Kuon and Rice⁹ compare programs related to engineering entrepreneurship at a number of universities. They classify the programs into three different models based mainly on where the program is located, the possibilities being in the engineering school of the university or in its business school or split between them. As we will see, in terms of this characterization, NEWPATH fits in the last category; in particular, the *entrepreneurship minor* that students complete is in the business school, while several of the other main activities that students engage in are in the Computer Science and Engineering (CSE) Department in the engineering school, and the culminating entrepreneurship-practicum is mainly in the business school but with active coordination with CSE. Standish-Kuon and Rice also consider a number of key factors that influenced the direction and organization of engineering entrepreneurship programs at those universities. As we will see later in the paper, most of the factors they consider had little or no impact on the development and growth of NEWPATH. Instead, the main factors that guided the evolution of our program were the reactions of the students in the program to various aspects of the program and, especially, their impact on students' growth as IT entrepreneurs; assessment results, detailed later, also guided this evolution. In addition, our focus, as noted above, on IT-based entrepreneurship played a major role in developing various components of the program.

In Section 2, we summarize some recent work related to models of learning. In Section 3, we detail various aspects of NEWPATH and summarize the importance role that the NEWPATH *community* plays in the success of the program. In Section 4, we summarize the results of assessments of the program; we also highlight some of the specific successes, in the form of IT enterprises that NEWPATH students have launched. In Section 5, we briefly consider some other programs in engineering entrepreneurship and compare them to NEWPATH. We then conclude with a brief summary of the lessons learned and our future plans.

2. Models of Entrepreneurial Learning

A number of authors^{10,11,12} have investigated some major problems that new enterprises typically encounter and the tasks that entrepreneurs must be effective at in order to address those problems. The latter include the ability to conduct market analysis, see the potential of new products and services, make decisions under uncertainty and risk, etc. Many schools have established curricula for *minor* programs in entrepreneurship designed to develop their students' abilities with respect to these tasks. In the next section, we will briefly detail the curriculum that NEWPATH students go through as part of their entrepreneurship minor. As we will see, these courses, which are in some respects similar to courses in the entrepreneurship minor programs at other schools and innovative in other respects, are designed to develop important skills for the future entrepreneur. We will also detail how the students' major programs are structured so that the completion of the

entrepreneurship minor does not require the student to remain in school for a substantially longer period of time than he or she would otherwise have to. As noted by Standish-Kuon and Rice⁹, this is one of the major issues that other schools that have focused on engineering entrepreneurship have had to contend with.

Over the last several years, a number of models have been developed corresponding to student learning in a variety of disciplines including science and engineering. These models stress the importance of students applying their knowledge in appropriate activities and, perhaps even more importantly, of interacting with each other and helping each other learn. Below we summarize some key findings from some of these developments and in the next section we will see how these findings have influenced NEWPATH.

The *How People Learn* (HPL) framework^{8,13,14,15} captures some general *learning principles*. According to HPL, the learning environment and learning activities should be designed to be *learner-centered*, *knowledge-centered*, and *assessment-centered*. Most importantly, HPL stresses the importance of organizing the learning environment to be *community-centered* in order to encourage students to learn from one another. The main idea underlying *constructivism* is that learners understand a new topic by constructing mental models¹⁶. *Constructionism* extends the idea by arguing that this can happen most effectively when students make tangible models, possibly in software, of the item in question^{17,18,1}. Scardamalia *et al.*^{19,20} posit that students learn most effectively when they engage in *knowledge-building*, as against *knowledge-reproduction*.

Fig. 1 depicts the *Community of Inquiry* (CoI) model⁷, another framework that stresses the importance of interaction among students to help them develop a thorough understanding of the topic under study. Although CoI was originally designed primarily for analyzing on-line

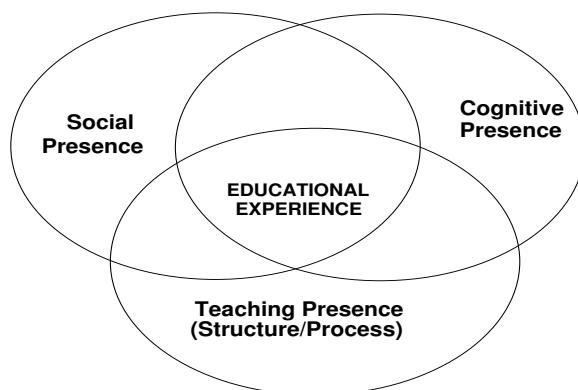


Fig. 1. Community of Inquiry

educational systems, it is also appropriate for learning environments that are (mostly or entirely) face-to-face. The three principal elements of the CoI model are social presence, cognitive presence and teaching presence. Social presence may be defined as the degree to which participants in the learning environment feel affectively connected one to another; cognitive presence represents the extent to which learners are able to, via interactions with each other, construct and refine their understanding of important ideas through *reflection* and *discussion*; and teaching presence is the

design of various instructional activities such as lectures *as well as* activities intended to facilitate interactions among students to help their learning.

To summarize, the learning environment should provide three mutually supporting components, these being a suitable set of instructional activities including appropriate activities in which students apply the concepts and ideas learned to solve realistic problems or, in the case of entrepreneurship, to create businesses or parts thereof; and have the students engage in discussions and other activities as a *community of inquiry* to learn from each other's experiences and understanding of key ideas. As Garrison *et al.*⁶ (who proposed the CoI model) put it, "... education is a collaborative reconstruction of experience". This idea of students forming a community-of-inquiry is especially relevant for engineering entrepreneurship programs where students need to see how the ideas they might read about or learn about in the classroom work in actual startups and to analyze the results by thoroughly discussing them with their peers. As we will see, a central component of NEWPATH is designed to do just that: help students learn by reconstructing and analyzing each others' experiences.

3. Program Details

Each year selected students in IT-related areas are admitted to NEWPATH. The areas include Computer Science and Engineering (CSE), Electrical and Computer Engineering (ECE), Computer and Information Science (CIS), and Management Information Systems (MIS). These students are expected, in addition to completing the requirements of their degree program, to take courses in entrepreneurship, complete internships in IT startups, etc., as detailed below. But unlike most other programs in engineering entrepreneurship education, NEWPATH is *not* a major program or a minor program, at the successful completion of which the student receives a certificate or diploma of some kind¹. Instead, NEWPATH is an *opportunity program* intended to nurture students interested in IT entrepreneurship. That is, it provides opportunities for students to deepen their understanding of important entrepreneurial ideas such as market research, venture capital, etc.; to sharpen their networking skills (and to create a useful, if small, network of successful IT entrepreneurs and others who can help them in their future entrepreneurial ventures); to develop their abilities to make presentations *related to potential IT startups* to different audiences such as IT developers and VCs; and, finally, to engage in a *community-of-inquiry* of students, all with a strong interest in IT-entrepreneurship, but with a wide range of levels of relevant knowledge and skills, to discuss their own experiences with startups as well as analyzing the experiences of other startups.

¹A NEWPATH student who successfully completes the five courses required by the *entrepreneurship minor* (see below) does receive a certificate to that effect. However, a student does not have to be in NEWPATH to complete that program; indeed, the entrepreneurship minor program is popular among students in many disciplines across the campus whereas NEWPATH is intended only for students interested in IT-entrepreneurship. Conversely, some active NEWPATH students do not complete all the requirements of the *entrepreneurship minor* and hence do not receive the certificate although their active participation in NEWPATH will help them enormously in their future endeavors as IT-entrepreneurs.

Admission to the program: NEWPATH has taken a multi-pronged approach to attracting a suitable mix of students. In the first step of the process each year, we obtain a list of students who met three specific criteria, and invite them to an informational meeting about the program. The criteria are major or pre-major in CSE, ECE, CIS, or MIS; at least a 3.0 GPA or no GPA at all, i.e., a first-semester student; and at most a certain number of credit-hours completed toward graduation. The first criterion is self-evident since these are the majors at our university that relate to IT. The second criterion is based on the expectation that students in NEWPATH should be able to complete their degree program in four years, even with the addition of an entrepreneurship minor (see below) that adds slightly to their overall program of study: students with high GPAs are more likely to have some AP credit to help offset the additional credit hours in the minor. The third criterion recognizes that students need enough remaining time in their program to complete the entrepreneurship minor, at least one internship, and the senior-year e-practicum, and to effectively contribute to and benefit from the NEWPATH community.

Of the invited students each year, roughly a tenth have indicated interest in attending the informational meeting, and have been informed of the place and time of the meeting. In other words, apparently a tenth of the high-achieving computing majors (at least, as freshmen or sophomores) have an interest in becoming entrepreneurs. About half of the interested students have actually attended the meeting. Of these students, about half have formally applied to the program by submitting a simple application with a one-paragraph essay question asking why they thought IT-startups tend to fail. The net result of this process has been that each year something like 3–4% of all the invited students have ended up in the program. About 6–8% of the students admitted to the program have been women or members of other groups underrepresented in IT majors. This roughly matches their percentages among IT majors as a whole. We would expect these ratios to apply to most other universities that may be interested in creating a similar program.

Program Curriculum: The NEWPATH curriculum consists of three main components: a) the student's computing-related major program; b) the entrepreneurship minor; and c) the culminating entrepreneurship practicum. The requirements of the student's major program, of course, vary depending on the particular major. For example, the CSE major consists of required and elective courses in a range of topics from software design principles and practices to algorithms, from computer systems and architectures to computer networking, from AI to computer graphics and video game design; and a culminating capstone project course which may, for example, consist of designing and implementing a set of web services to meet the requirements of a real client.

The *entrepreneurship minor*, offered in the business school, specialized for NEWPATH students, requires the student to take five courses: a course on *innovation and entrepreneurship in modern business* which examines the theoretical foundations of innovation and entrepreneurship; followed by a course on *new venture creation* which explores the process for creating new ventures, including ideation, evaluation of business opportunities, business planning, and assembling business resources. The remaining three courses which may be taken in any order are: *entrepreneurial marketing*, focusing on marketing concepts and methods of entrepreneurs leading growth-oriented companies; *entrepreneurial financing*, which presents a two-part process in which companies in-

vest in both real and human capital assets and then find the financial capital necessary to pay for those investments; and *high-performance ventures*, which explores the key managerial practices and skills necessary to lead a successful growing business.

The *entrepreneurship practicum* (e-practicum), the culminating component of the NEWPATH program, is intended to give student teams a unique opportunity to engage in an intense, several-month long activity in which they are required to apply their knowledge and skills—in IT and its applications, as well as in entrepreneurship—to go through the planning, creation, and deployment of a small IT venture of their own. The key goal of the e-practicum is to develop a student's ability to find, evaluate, and develop raw technical ideas into commercially viable product concepts, and build those concepts into business propositions. Interestingly, the e-practicum is piggy-backed onto the business school's Entrepreneurship MBA program. That is, the students in the course are not just NEWPATH students; indeed, they are a minority, with the majority being MBA students.

Assessing the commercial venture potential of emerging technologies can be a complex process. To ensure that students develop the necessary skills to perform such assessment, the lectures present suitable project management models and teams are expected to adopt one of these. Thus, in addition to learning the commercialization process, students acquire expertise in managing complex projects. The first half of the e-practicum focuses on ideation and validation; the second half on commercialization. Each team identifies promising technology areas and sources of product concepts, that are within the technical capability of the team, and prioritizes them. Product definition and selection criteria include market analysis for the market needs and size, competitors, commercialization strategies and profit margins, and development and technical risks.

In the second half of the e-practicum, the team builds the case for commercialization. In effect, the team is transitioning from selecting product concepts to developing a business proposition. More information is required in order to make the assessments, and the functional assessments provide the structural framework for information gathering in a prioritized manner. The process is iterative: when flaws or deficiencies are discovered, the teams might redefine the product concept and revisit the assessments. Student teams interact closely with potential customers, potential competitors and industry thought leaders as they validate their assertions about the commercial viability of their projects. The teams decide on how the business will be financed; define an operating model for the business, including a management plan; and prepare a go-to-market strategy based on a market and competition analysis. This phase culminates with the development of a business proposal—a “selling document”—for a startup. The final task for the team is a full-scale “pitch” to potential investors. Should a pitch be accepted for funding, or if the NEWPATH team should simply decide to pursue the business plan on its own, it is given the license to do so. Students learn through the e-practicum experience that failure of IT enterprises from startups to large companies is often not from their product development capabilities but from poor vision and understanding of technology advancement directions and from lack of a winning market strategy. Thus, at the end of the e-practicum, NEWPATH students reconsider the key question, why do so many IT-startups tend to fail, that they tried answering in their original application to the program. Except now, they are well on their way to becoming successful entrepreneurs.

The curriculum described above was designed by engineering faculty and business faculty working in close cooperation. As noted previously, a version of the entrepreneurship-minor program already existed in the business school. That program, however, only required students to take the first two courses (respectively on innovation and entrepreneurship in modern business; and new venture creation). Students were allowed to choose the remaining three from a wide variety of courses, including from several offered outside the business schools, for example, in departments such as social science. After extensive discussions, the engineering and business faculty decided that for NEWPATH students, it would make more sense to take three specific courses (all taught in the business school) that address problems that IT startups tend to face, these being, as listed earlier, ones focusing on entrepreneurial marketing, entrepreneurial financing, and skills and practices necessary to lead high-performance ventures.

The engineering and business faculty also strongly felt that a culminating, experiential component that allows NEWPATH students to put some of their knowledge and skills into practice would be extremely valuable. At the same time, there was only a small handful of students in any NEWPATH cohort so it was not clear how such a culminating course could be offered. Partly as an experiment, we decided to have the first cohort of senior NEWPATH students to join the teams in the entrepreneurship practicum course of the MBA-Entrepreneurship program². Naturally we had misgivings about how well such an arrangement would work, since the MBA students, many of whom have had years of experience as business professionals, may not welcome NEWPATH students as part of their teams. As it turned out, however, the unique combination of IT skills and enthusiasm for IT entrepreneurship that NEWPATH students represented were the perfect match for the more mature MBA students. Indeed, many of the most successful teams in the MBA program, including ones that competed effectively in the annual business-plan funding competition of the business college, were those that included NEWPATH students.

One final point is worth noting concerning the NEWPATH curriculum. A problem that engineering entrepreneurship programs have reported⁹ is the substantial additional time to graduation that students face in having to take the extra courses, beyond the ones required for their engineering major, required in such programs. We were able to partially address this problem by allowing the student who completes the entrepreneurship minor to count some of the credit hours of the minor toward meeting the technical electives requirements of their IT-related major.

Internships in IT Startups: A key component of the program is *student internships* in IT startups. *TechColumbus*, a public-private partnership whose mission is to accelerate the advancement of the region's innovation economy and which has been involved with NEWPATH since its inception, is key to this aspect of the program. The main goal of this component of the program is to supplement the student's academic development in computing and entrepreneurship with quality experiential learning at entrepreneurial firms led by successful IT entrepreneurs. Our value-proposition to these entrepreneurs is that NEWPATH students will provide great enthusiasm and (possibly surprising) technical strength. As an added incentive, especially given that many of

²We could arrange this in part because one of the key members of the NEWPATH team is also director of the Entrepreneurship Center in the business school.

these startups tend to be on shoestring budgets, the program subsidizes the first three months of a student's internship by paying up to 50% of the student's wages from NEWPATH funds.

Briefly, the approach we have developed and fine-tuned over the last several years works as follows. In January/February of each year, we ask NEWPATH students interested in internships during the upcoming summer to prepare, by a specified deadline, a short resume and a brief paragraph describing their main interests and IT-related technical qualifications. We provide them models based on students' resumes/paragraphs from previous years. At the same time, we work with TechColumbus to get in touch with CEOs or other senior people in local IT startups, to interest them in considering hiring NEWPATH students as interns. At the start of each month, TechColumbus arranges, on its campus, an informal *mixer* at which CEOs and other senior people from local high-tech startups, venture capitalists (and potential VCs), and others interested in enterprises based on innovative technology can gather to discuss their common interests and identify potential opportunities for working together. Once NEWPATH students' resumes are ready, TechColumbus arranges, immediately prior to one of these mixers, a session at which interested people from IT startups can meet with the NEWPATH students, discuss the students' interests, backgrounds, and possible matches with their own needs.

Several days prior to this session, we send out, to the startups, a flier describing the NEWPATH program and the students' interests in working as interns in their respective companies. The flyer provides a brief summary of NEWPATH's goals and approach, and describes the kinds of internships that would be appropriate for our students, these being ones that would help the student develop his or her entrepreneurial skills. The flyer also provides links to a (password protected) website where the interested startups can access the students' resumes and brief descriptions of what they are most interested in. The session is held in a conference room with NEWPATH students, people from the startups, people from TechColumbus, and some NEWPATH faculty, seated around a large table. Typically, there are about ten NEWPATH students, people from about ten startups, two or three members of TechColumbus, and two or three NEWPATH faculty. The main part of the session consists of brief overviews of NEWPATH and the internship program by a member of TechColumbus and by one of the NEWPATH faculty, followed by brief introduction by each student, and then a presentation by people from each of the startups outlining the main business of the particular startup and what they are looking for in their interns, followed by questions and answers. The meeting then breaks up, more or less slowly, into small groups with each group consisting of one or two students getting into serious conversations with a couple of people from the startups. At some point the groups, at their own pace, move out of the conference room to join the mixer where they continue their discussions, sometimes merging with other groups. NEWPATH faculty and TechColumbus members stay around to answer any questions but the discussions are mostly between the students and the startups and any VCs who might be at the mixer. Often people from startups who are not planning to hire NEWPATH interns during the coming summer but have done so in previous years join in to speak of their (almost uniformly very positive) experiences with NEWPATH interns. Similarly, senior NEWPATH students who are about to graduate might attend the mixer and talk about their experiences. The purpose of this session at TechColumbus is not for the startups to hire interns immediately (although that does happen). More commonly,

following the meeting session and mixer, senior people from particular startups get in touch with individual students that they felt were exceptionally well-matched to their needs, and arrange for more extensive interviews and discussions. Typically, every student interested in an internship finds a suitable one.

From the point of view of the startups, the main reasons for participating in the program are to:

- Gain access to talented candidates with a passion for entrepreneurship;
- Have flexibility in addressing their human resource needs and at a low cost, given the NEWPATH subsidy;
- Increase the organization's visibility, brand awareness and allure on campus;
- Cultivate stronger relationships with our university, its students and faculty.

The internship program has been extremely successful. The startups that have hired NEWPATH students as interns have been enthusiastic in their praise of the students' abilities, work ethic, and enthusiasm. Students have learned first-hand lessons concerning such key issues as keeping the startup running even in the face of serious uncertainty about future prospects while pursuing funding opportunities, and these lessons are likely to be key to their future success. In some cases, the startups have persuaded students who have graduated from the program to join the company on a full-time, permanent basis; and these graduates have become key members of those companies. In other cases, entrepreneurs behind the startups have become trusted, dependable long-term mentors to help the student's entrepreneurial career.

Community of Inquiry: One of the unique aspects of the NEWPATH program is the central role that *community* plays in the program. When the program was originally designed, we knew that we would be heavily dependent on TechColumbus and the local startup community to find suitable internships for NEWPATH students. What we discovered within a short time of the program's start was that engaging the students in a number of overlapping communities was essential to achieving the program's primary goal of helping the students become successful IT entrepreneurs. To coin a phrase, it takes the NEWPATH community to nurture an IT entrepreneur! Below we briefly summarize some of the key activities and the related communities that NEWPATH students participate in and how they contribute to the students' growth as entrepreneurs.

A central component of NEWPATH that helps organize these various activities, coordinate students' participation in them, and, most importantly, help students share, analyze, and learn from each others' experiences in these activities, is the *weekly seminar*. All NEWPATH students, from freshmen to senior are expected to attend the seminar regularly. Initially, the reason we organized a common seminar for all students, from freshmen to seniors, was that each cohort was relatively small and organizing a separate session for each would not have made sense. Soon, however, we recognized that a single joint weekly meeting students at all levels was very helpful because it helped junior students learn from senior students' knowledge and experiences on the one hand; and, on the other, it allowed senior students, as they interacted with their junior counterparts, to reflect on their own growth and the evolution in their thinking about various aspects of entrepreneurship.

Indeed, occasionally we have had past NEWPATH students who have graduated from the program come back to attend one of the weekly seminars and talk about their entrepreneurial activities both during the time they were in the program and since their graduation.

Below, we briefly summarize the various types of presentations that are made at the weekly seminar and how these help improve NEWPATH students' understanding of IT entrepreneurship.

- *Research presentations:* Although the courses in the entrepreneurship-minor program provide students with an intellectual foundation for understanding important issues related to entrepreneurship, we felt that it would be useful to encourage individual students to research particular topics that are especially relevant for IT-enterprises; e.g., *crowdfunding* or using on-line tools for performing market research, the inside story behind successful (as well as failed) startups, etc. Further, we wanted all students to learn from each students' research. Hence, we adopted the following approach. At the start of each term, NEWPATH students may apply to participate in e-research during the term. The student has to identify a particular topic related to IT-entrepreneurship that would be suitable for such research. If approved, and most such proposals are approved, the student will be eligible to receive financial support of \$10 per hour for work of up to five hours per week. Near the end of the term or near the start of the following term, the student is required to make a presentation summarizing the main ideas that he or she has learned from the research. The presentations are summarized and made available on-line. Freshmen students do not, typically, apply to do e-research since they are not sure what topic to research or how to get started etc. However, after attending a handful of presentations by more senior students, they not only develop an understanding of the topics of the particular presentations but also understand how to do similar research.
- *Ideas for startups:* Many students in the program have ideas for how a particular new/recent technology can be used as the basis of a new startup. Indeed, many students are first attracted to NEWPATH because they have such ideas, do not know what to do with them, and want to be able to discuss the ideas with others who might have more experience with startups than they themselves have. The sessions at which these presentations are made tend to be the ones that draw the most active participation from all students. The degree of camaraderie and cooperation that students display in such meetings in helping each other hone their understanding and analysis of the technology and in critiquing business aspects of the enterprise is remarkable and attests to the strength of the *community of inquiry* model.
- *Presentations by startups:* Fortunately, in the last several years, a number of IT entrepreneurs have made the area their home, including many supported by TechColumbus, with seed funding or office space and facilities while they get started. Frequently, however, especially given the rapid changes in IT technology, these entrepreneurs need help from young "geeks" who are not only immersed in such technology but also have a good background in computing fundamentals and a strong interest in working with startups. This is a perfect fit for many NEWPATH students. Hence we frequently have presentations where the CEO of (or another senior person from) the startup describes the basic idea of his or her business, describes the particular technical (and non-technical) problems they are encountering and possibly how those problems are impacting their future plans, and what opportunities might be available for NEWPATH students to work with them either on a short term or a long-term basis.

- *Presentations about technical conferences:* The importance of *networking* for entrepreneurs, including for IT entrepreneurs, can be hardly overstated. It is never too early for would-be-entrepreneurs to work on creating their networks. For a budding IT entrepreneur, the network should include technology gurus who can help with technical questions, successful entrepreneurs who may be willing to provide guidance on various questions about launching new enterprises, would-be VCs who might be willing to risk small amounts on an ambitious young entrepreneur, and others who might be able to help make contacts with these people.

In order to help NEWPATH students develop their networks, the program strongly encourages them to attend various events where they can expect to meet and interact closely with such people. One example is professional IT meetings such as the *Ruby Conference* (<http://rubyconf.org>). NEWPATH provides support with registration and other expenses for NEWPATH students who wish to attend such conferences and have the technical background to benefit from doing so. Occasionally, advanced NEWPATH students may even make presentations at such conferences. On returning from such an event, the student makes a presentation to the NEWPATH group, discussing both the major technical points that were discussed at the conference and their possible use to create interesting software, as well as insights into building relations with the people in that community.

- *Presentations about legal and other issues:* Legal issues such as intellectual property, copyright, etc., are often problems for IT entrepreneurs. The courses in the entrepreneurship minor touch on some of these topics but they do not go into details that are particularly relevant for IT enterprises. To ensure that NEWPATH students are aware of these issues, we occasionally have someone from the *technology commercialization office* of the university or someone from TechColumbus talk about them. These presentations tend to be somewhat like lectures in courses until one of the senior NEWPATH students brings up a recent high-profile case involving the issue under discussion; at that point, the entire group gets into the discussion!

To summarize, a key idea behind the structure of NEWPATH, as described in this section, is that a close-knit community that meets regularly, whose members share a common interest in IT-entrepreneurship but, at the same time, have diverse backgrounds with respect to their levels of entrepreneurial knowledge and experience, is very effective in helping each member grow. This is precisely what the work on the *CoI* model^{6,7} has shown and is, we believe, a big reason for the effectiveness of NEWPATH.

4. Program Assessment and Results

NEWPATH is participating in both a process and an outcome evaluation. In order to minimize bias in the evaluation, it is conducted by an independent group specializing in program assessment. In this section, we summarize the assessment approach and the results. The process evaluation includes interviews of graduated or soon-to-be-graduated students to examine their entrepreneurial activities, and interviews of startups who have had NEWPATH participants as interns. The outcome evaluation consists of a quasi-experimental evaluation where NEWPATH participants are compared to a group of similar students who did not participate in the program. Comparisons

include attitudes, behaviors, and knowledge regarding entrepreneurship. The goal is to attempt to answer questions such as:

- Do participating NEWPATH students develop (1) stronger positive attitudes toward entrepreneurship, (2) greater interest in pursuing IT business ventures, and (3) more entrepreneurial knowledge and skill than comparable students who do not participate in NEWPATH?
- Are NEWPATH students more likely to pursue IT startup career positions after graduation than comparable students?
- Which NEWPATH program components are most critical at producing outcome effects?

Quasi-experimental design: The outcome evaluation design consists of administering a pre-and post-test survey to each incoming cohort of NEWPATH students and to a comparison group of students who attended the initial recruitment meeting but did not become members of NEWPATH, then administering a post-test survey at the end of the following academic year to both groups.

The pre-survey questionnaire includes 20 attitude items, 14 questions regarding the students' perceived readiness to become an entrepreneur, and 20 skills assessment items. The post-survey questionnaire consists of the 14 readiness questions, a short series of questions to rate the NEWPATH program, and the 20 skills assessment items. One important difficulty is that both the "treatment" group and the comparison group are relatively small. Hence it is difficult to conduct statistical analysis that compares the skills assessment items across time.

Quasi-experimental results: We summarize the results with respect to students' entrepreneurial attitudes, their level of entrepreneurial knowledge, and their perception of the program.

Entrepreneurial attitudes: First, we looked to see whether there were any differences in pre-survey respondent entrepreneurial attitudes between the "Admitted" and "Not Admitted" groups using an independent-samples t-test, confirmed with non-parametric group-difference test (Mann-Whitney test). The survey is designed to measure five factors: Ownership, Independence, Income, Tolerance of Risk, and Work Effort. The results from a recent year appear in Table 1.

Table 1: Entrepreneurial Attitudes at Pre-Test, 2011-2012 Cohort

Factor	Admitted (N=20)	Not Admitted (N=8)	Difference	Significance
Ownership	3.42	2.46	0.95	P<.001
Independence	2.40	2.17	0.23	SD
Income	2.63	2.56	0.07	NS
Tolerance of Risk	2.44	2.09	0.35	SD
Work Effort	3.52	3.25	0.25	SD

NS = not significant

SD = substantial differences

These results suggest that the students admitted into NEWPATH scored statistically significantly higher in the Ownership factor, indicating that those students were more interested in having ownership of their efforts. However, as the respondents in the pre-test survey comprise the entire population and the total number of completed surveys is small larger differences can indicate potential emerging patterns. In this case we see that Independence, Tolerance of Risk and Work Effort are also substantially higher for those admitted than those not admitted for this cohort. Interestingly, the remaining factor, Income, shows minimal difference between the two groups, contrary to what one might have expected, i.e., that the potential for large incomes as entrepreneurs would be a major motivation for students.

Entrepreneurial knowledge: In order to assess the impact of the program on students' entrepreneurial knowledge, we designed a number of multiple-choice questions related to key concepts. For example, one of the questions reads as follows:

In the earliest stages of a startup, which of the following is a common form of financing?

1. Venture capital
2. Angel funding
3. Personal debt and savings
4. IPO (Initial public offering)
5. All of the above.

The correct answer is (3), personal debt and savings. Another question reads as follows:

You have just met with a key potential account. It could be a large-scale project and also bolster your company's credibility in the industry. However, the potential client is afraid to do business with a startup. The best way to win them over is to:

1. Ask your world-famous VC investor to call the customer
2. Offer to do a pilot implementation at a deep discount
3. Arrange for the CEO of your company to meet with the customer
4. Tell the customer you will contact them once your company is "proven" in the marketplace
5. Get a character reference from friends or family
6. None of the above; there is no way to win in this case.

The right answer here is (2), offer to do a deeply discounted pilot implementation.

Other questions were similar. The number of students in individual years who completed the post-test was rather small. Table 2 provides results, summed over all the years.

Table 2: Entrepreneurial Knowledge (Summed over all years)												
	Pre-test						Post-test					
	Admitted			Not Admitted			Admitted			Not Admitted		
	N	Mean	Range	N	Mean	Range	N	Mean	Range	N	Mean	Range
Total	36	10.86	3–15	17	9.29	4–15	14	11.07	6–15	12	9.25	3–15

Although there seems to be some evidence that the program has a positive impact on the entrepreneurial knowledge that students gain the course of the program, the relatively wide range

in the students' scores as well as the small number of students who took the post-test make the conclusions rather unreliable. This part of the assessment needs to be continued in order to help draw more reliable conclusions.

Student opinions of NEWPATH: All students who completed the post-survey were asked whether they were currently in NEWPATH and, if so, to rate certain aspects of the program. Specifically, students were asked to rate, on a scale of 0 to 10, 0 being the lowest rating and 10 the highest, how well NEWPATH performed with respect to each of the following:

- Providing you with the opportunities you need to learn how to become an entrepreneur.
- Providing you with the knowledge (such as funding sources, business permits and licenses, and copyright /patents) you need to become an entrepreneur.
- Providing you with the practical experience you need to become an entrepreneur.

The mean scores for these ratings ranged from 8.4 to 8.8 which seem very satisfactory.

NEWPATH Ventures: The ultimate goal of the program is to nurture students to become IT entrepreneurs and to start their own ventures. NEWPATH has indeed been quite successful in achieving this. We list a few of the ventures that current or former NEWPATHers have launched or are in the process of doing so.

- *uTap* is a web-based company created by two NEWPATH students that combines elements of Facebook Places, Google Maps and Twitter. *uTap* is a location-based application designed to facilitate communication between Ohio State students. The idea for uTap is based on the observation “that everyone is trying to meet the people around them,” to quote one of the students who created this venture. “With uTap, students will feel much more comfortable asking for help or communicating with classmates while controlling who their audience is.” *uTap* was one of the companies that was selected for seed funding by the business college’s competition.
- *ApproveIO* is a universal payment gateway that is easy for both merchants and developers. The gateway is flexible and supports all major processing networks. Merchants can obtain a new account or connect an existing one. Changes in the merchant account can be made quickly without changing any of the code on the merchant’s site. *ApproveIO* offers features that other gateways don’t support. The company was founded recently by a NEWPATH student.
- *LaunchGram* aggregates pre-release demand signals for products coming soon. Consumers can create a *LaunchGram* account and subscribe to news about imminently launching products of interest. Once users subscribe, they can receive notifications via email with curated updates about product release date, pre-order availability, photos and video. The team is currently focusing on video games, movies, gadgets, and cars. Expansions are being planned for books, music, and more. *LaunchGram* was mentioned very favorably by TechCrunch and was another company that was selected for funding by the business college’s competition.

In summary, the formal assessments show positive results although the number of students involved in the assessment, both in the pre-test and in the post-test were relatively low. Hence we plan to continue these assessments in the coming years to arrive at definitive results. But the results

in terms of the number IT enterprises launched by NEWPATH students and their successes in competing with other entrepreneurs who have much longer experience as professionals has been remarkable and attests to the validity of the NEWPATH approach to nurturing IT entrepreneurs.

5. Conclusions

We start with a brief summary of some engineering entrepreneurship programs that have been recently created at various schools and how they relate to the NEWPATH program. The program at North Carolina State requires students to complete three courses titled, respectively, Introduction to Entrepreneurship and New Product Development (1 cr-hr), and Engineering Entrepreneurship and New Product Development I and II (3 cr-hrs each). In the first course, students work in teams led by *senior* students completing their capstone project. Thus students get exposed to different areas of design and development. In the second course, students are exposed to business aspects of entrepreneurship and come up with a design for an engineering product. And in the third, they form entrepreneurship teams to prototype their designs ideas. The entrepreneurship program at the University of Pennsylvania aims to “to train the founders and leaders of tomorrow’s high-tech ventures”. Students complete two courses. The first provides an introduction to the early phases of a high-tech venture. The second investigates the necessary steps for planning a high-tech venture. Student teams develop and present a high-tech business plan. The emphasis in both courses is on the risks and determinants of success in high-tech entrepreneurial ventures. The program at Washington State has a unique component: a 3-week program that consists of an initial week on campus where students learning a variety of key skills including communication, basics of finance, etc., followed by a 2-week trip to Silicon Valley where the students are provided with opportunities to interact with entrepreneurs as well with venture capitalists. This is followed by a 12-week internship at a small or large company at the end of which students prepare a report that critiques the summer experience and outlines ideas they might have developed for new companies. Although some aspects of these programs have some similarities to parts of NEWPATH, the combination of activities that make up NEWPATH, especially the central role of the NEWPATH community, is unique. The other unique aspect of NEWPATH is the extensive set networking opportunities that it provides students which enable students to grow as IT entrepreneurs.

A key lesson that we learned early on was the importance of creating a close-knit community of students at *all* levels that enables them to learn from each others’ experiences. This is especially important for entrepreneurship which is not just an academic topic that can be fully mastered by taking some courses. Students need to discuss and reflect on each others’ experiences and ideas related to enterprises. And having a community that includes students at all levels helps both the novice students as well as the more experienced ones. The other lesson we learned was the importance of helping students to get an early start in creating their network of contacts with successful entrepreneurs, technology gurus, potential partners in future enterprises, and potential venture capitalists; and we tailored the program components accordingly. This does require some minimal financial resources which we were fortunate to have in the form of a federal grant. That grant will end soon and an important part of our future plan is to create a fund, supported by successful local

startups, to continue these activities. Our other plan is to continue our formal assessments. Since several additional students have graduated recently from NEWPATH, we should be able to gather more assessment data by working with these students.

We also hope to work with other schools to help them implement similar programs. Further details concerning NEWPATH are available at our website²¹. We believe that the success of NEWPATH can be replicated as long as the main lessons summarized above are kept in mind.

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