Developing Entrepreneurial Skills in IT Courses: The Role of Agile Software Development Practices in Producing Successful Student Initiated Products

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Abstract

Universities are under increasing pressure to provide real world experience to students. Entrepreneurial courses are prevalent in business schools and have been shown to develop entrepreneurial skills. Entrepreneurial skills are equally important in the development of IT innovations. The research in this area of education is not as prevalent. We argue that Agile Software development methods, along with other key course characteristics enable students to learn entrepreneurial skills related to IT product development and do so in an environment where innovation can flourish. We present some preliminary data, which demonstrates some success in the course in developing entrepreneurial skills, with a particular focus on the use of Agile Development and mentoring methods in developing those skills.

1. Introduction

The mounting research in entrepreneurship provides convincing evidence that entrepreneurs can be developed through education and training, and are not simply born [1]. Pittaway's [2] systematic review of the entrepreneurship education literature, as well as other previous reviews [3, 4] speak to the ubiquity of entrepreneurship courses within business schools, the developing maturity of entrepreneurship programs, as well as a significant understanding of entrepreneurship through academic research. Major areas of research according to Pittaway's review include the exploration of management training, the study of the factors which contribute to the propensity to become an entrepreneur, teaching and learning pedagogy, and institutional policies towards entrepreneurship education. Those who are prepared to act as entrepreneurs—those who are willing and able to pursue the implementation of new and useful ideas, cannot only develop new products, but are also useful within large corporations [1], allowing for larger returns on research and development efforts [2]. The research is mature enough that research studies should focus on more particular matters of entrepreneurship education instead of demonstrating whether or not it should or can be taught.

The current study focuses on the development of entrepreneurship education in the area of IT product development and innovation. This is a compelling area of research, since much of research in the field of information systems and other related disciplines has explored in great depth the development, diffusion [5] and adoption [6], and impact of IT in organizations as well as in a broader market or societal context. While there are some studies specifically focusing on IT entrepreneurship [7, 8], the present effort adds to this emerging body of research in at least three ways.

First, in the current study we illustrate how knowledge from the field of information systems can be used to design an experiential entrepreneurial course in IT product development. Specifically, we look at how using the Agile software development process, in conjunction with other key course characteristics such as instructor mentoring, product idea ownership, and autonomy creates an ideal environment to both develop the propensity of students to develop innovative IT products, and provide an ideal environment for entrepreneurial IT product development at the same time. We explore these and other key characteristics of an IT innovation course recently implemented outside the business school in a large university in the Midwestern United States.

Second, we provide some support for success of this course in the development of an IT entrepreneur through perceptions of increased skills and confidence in the product development process as well as team related processes. Third, we demonstrate the success of the course via student entrepreneurial behavior of developing products and by validation from external businesses and venture capitalists.

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Before turning to these three objectives, we first discuss IT entrepreneurship—and specifically, the characteristics an entrepreneur as well as the context within which entrepreneurship occurs. We also review Agile software development and mentoring, and discuss their relationship to the development of IT entrepreneurs and the provision of an ideal context for entrepreneurship to occur.

2.Background

2.1 Entrepreneurship & Related Concepts

Entrepreneurship is closely related to the concepts of creativity and innovation. Amabile defines entrepreneurship as a special type of creativity which is involved in the implementation of creative ideas [9]. In this discussion of entrepreneurship, creativity is defined as a focusing on the development of novel and useful ideas. Innovation focuses on the successful implementation of an idea (within an organization). Entrepreneurship is a special type of implementation of a novel and useful idea—it must be connected with a new product or new method of developing and delivering a product.

The spirit of entrepreneurship lies in the fact that there is an individual willing to undertake the responsibility of pursing the implementation of the creative idea, in spite of potential hardships. Entrepreneurship is defined by Stephenson [10] as "a process by which individuals-either on their own or inside organizations-pursue opportunities without regard to the resources they currently control. Entrepreneurship is differentiated from innovation largely in the fact that an individual or individuals are willing to bear the risk of implementing an innovation. This is why entrepreneurship is often associated with starting a small business. However, for the present effort, we are interested in developing an individual's capacity to implement a novel, useful idea in a way that could translate to innovation in a small business or in a larger organization.

2.2 Characteristics of an Entrepreneur

Research into the characteristics of an entrepreneur range from gender and background characteristics [11, 12], to personality traits [9, 11], to knowledge of business practices and risks [13, 12], perceptions of barriers and support factors when contemplating entrepreneurial activities [14] as well as access to support networks [15], and the nature of motivations surrounding the innovation opportunity[9].

Amabile's [9] dimensions of individual creativity, which she uses to explain entrepreneurial behavior in organizations, provides a useful framework for grouping the type of characteristics. The framework emphasizes that creativity leading to entrepreneurship arises from three elements: domain expertise, creativity skills, and motivation. Each of these is discussed below:

Entrepreneurial knowledge enables the entrepreneur to recognize and take advantage of opportunities. There are recognized skill sets which enable an entrepreneur to act. Expertise in domain of innovation is critical [9]. Expertise creates a larger "network of possible wanderings" [16].

Many of the personal characteristics relating to successful entrepreneurship revolve around skills and attributes specific to the creative process: thinking skills such as an intuitive problem solving style [17] and the ability and confidence in the ability to be creative [9, 18]. This can also include a tolerance for ambiguity. Additionally, team building skills, networking skills [15] and the ability to work with customers can be crucial as well.

Finally, motivation has been linked to creativity and entrepreneurship—where intrinsic motivations, or motivations which arise from one's internal attitude toward an activity, are linked to creativity [9, 19]. One aspect that is continuously linked to the maintenance of intrinsic motivation is autonomy, or practices that allow an individual personal control of the conditions in which he completes his work [20].

While research has not extensively explored the extent to which entrepreneurial characteristics of students has led to actual business startups or product developments, skills such as creativity, market awareness, flexibility [21], startup knowledge, and confidence [22] have been found to correlate with the intention to become an entrepreneur. Assessments of entrepreneurial education which evaluate student's perceptions of themselves [23] reflect many of these dimensions. In the following section, we will describe how an agile software development approach was used to increase students' capacity for domain expertise, creative thinking skills, and motivation or creative efficacy.

2.3 The Entrepreneurial Environment

Organizational motivation to innovate—Cohesiveness of the group enables the individual to introduce new ideas without censure. If the entrepreneur perceives that an organization will be supportive of the innovative behavior, by supporting diversity, and the development of new ideas, then he or she will be more likely to innovate [9].

Management Practices—allowing a degree of freedom or autonomy to individuals in the conducting of their own work [20] Matching individuals to work assignments, well balanced groups that trust each other and communicate well.

Resources—Resources which facilitate entrepreneurial creativity include people with expertise, funding, information, and training [24].

3. Increasing Students Entrepreneurial Skills Using Agile Methods

In this section, our usage of Agile Software Development in our IT innovation course is described in detail, followed by a description of how the course enhances students' abilities to develop an innovative IT product, as well as providing the proper environment for IT product innovation.

3.1 Agile Software Development and other Key Features

3.1.1 Agile Overview

Agile software development enables individuals in a software development team to quickly deliver a product and do so with a high degree of collaboration with the customer. At the heart of the design of Agile Methods is the desire to enable a software development team to perform as a Complex Adaptive System [25], a set of autonomous agents which have the ability to coordinate together to respond/adapt to their external environment.

According to Vidgen, Agile teams are able to respond quickly to customer's needs by having 1) the ability to match the rate of change of the customer 2) optimize the ability to self-organize, and 3) synchronize exploitation and exploration—essentially know which practices to keep and which to abandon as new practices are learned. There is a high degree of conceptual overlap between the makings of a complex adaptive system and the capabilities necessary to enable a development team effort to lead to successful new product development [26]. New product development teams need capabilities, which include including awareness of the market orientation, absorptive capability (the ability to learn), coordination and collective mind (both aspects of good self-organizing skills.

3.1.2 Agile Software Development Skills

The goal of Agile Software Development is to enable a software development team respond quickly to changing business needs. Evolving business needs are a reality of many organizations, which translate into evolving requirements [27].

There are many flavors of agile software development methods. The most commonly implemented is Scrum [28]. The key components of the scrum method are:

1) Iterative development of the software broken down in to *sprints* where a deliverable piece of software is created each sprint.
2) The utilization of *user stories* as a primary method of documenting requirements. User stories are one or two sentence descriptions of a chunk of functionality (or software related work). User stories enable the quick effort estimation, prioritization, and division of work on a software project. User stories serve as reminders for conversations where the details of the user story are elaborated and recorded as acceptance tests.
3) The creation, prioritization, and maintenance of a *backlog* at the beginning of a software development project where in initial set of user stories is created and prioritized.
4) *Daily Standup Meetings* are short (short enough that standing remains comfortable) status meetings where each member of the team explains what was accomplished and any issues that prevent further work.
5) *Sprint Planning Meetings* and *Retrospectives*. At the beginning of each sprint, the user stories to be developed are discussed and prioritized, and the work for the sprint is finalized. During Retrospectives, the team reviews work for the sprint discussing what lessons from the sprint could be taken forward into the method of working in the next sprint.
6) *Other* There are several other technical practices such as unit testing, continuous integration,

Teaching agile software development in an IT innovation course provides students with raw project management knowledge and skills gained through direct experience. There are several skills which can be obtained through experience with Agile in the classroom setting [29], such as:

- Breaking down a project task into smaller tasks
- Estimating effort needed to complete software development work
- Negotiating and prioritizing features
- Interacting with customers / product owners

All of these practices are widely used in industry, enabling students to participate in or lead teams of developers with greater confidence.

3.1.3 Autonomy as a Complementing Key Course Structure

A key aspect of Agile is that team members are free to act on their own, without too much interference of

process. Additionally there is a joint sense of ownership of the code, instead of a single motivation to lead.

3.1.4 Course Instructor as a Product Owner / Mentor

There is a natural fit between the product owner role in Scrum and the role of the course instructor as mentor. The resources which a mentor would provide for a student team would be very similar to the resources provided to an actual software development team.

3.2 Developing IT Product Innovation Attributes and Skills

Motivation: Students experience a dramatic shift from conventional lecture-based courses where projects are assigned to being free to select their own project. This allows student's work to hinge more heavily on intrinsic motivation as opposed to motivation to complete the course to get a good grade. Additionally, within their project teams, they act as autonomous team members, free to make decisions as to how they complete the work.

Domain Expertise: Students develop understanding of the Agile process as well as developing some of the necessary knowledge of programming tools to develop IT Innovations, as well as knowledge of marketing.

Key to the development of entrepreneurs is the knowledge organization or cognitive strategies that the mentor is able to bestow upon the protégé. Mentors also play a key role in shaping the attitudes and perceptions of students. They can make the idea of developing a new IT product seem more possible

In an Agile setting, a mentor acts much like a product owner and a scrum master, interfacing the team with the customer who will develop the software. The product owner/scrum master also helps to remove barriers for members of the team. Finally, the mentor can assures that students have a serious attitude towards the Scrum practices, and that the practices are followed correctly.

Creative Process Skills: There are several skills associated with Agile software development which could be considered creative process skills. The creative process model [30] indicates there are eight related processes associated with developing and implementing innovative ideas: 1) problem definition, 2) information gathering, 3) idea generation, 4) conceptual combination, 5) idea selection, 6) idea evaluation, 7) implementation planning, and 8) solution monitoring. *Much of the difficulty of software development lay in properly defining the requirements. Many of the creative process steps must be performed simultaneously—the problem must be defined while new information, new ideas, and new understanding emerges about how the software will be designed to address the problem. The Agile process addresses much of the complexity of the requirements by tackling the problem iteratively, allowing emergent creative knowledge to be incorporated into future iterations.*

3.3 Creating an IT Innovation Environment

Organizational motivation to innovate: the motivational climate is shaped primarily by allowing the students to define their own projects and to be the generators of the innovations and solutions. The students own the idea. Also, the grading policy focuses on the creative process not solely on outcomes. Students who are graded on specific project outcomes may be less motivated to innovate than those who. The organizational structure is also shaped by having small, self-selected teams. On a broader level, the organizational involvement may also include the willingness of the local venture capital investing community to spend the time providing students with feedback about their products as well as actually offering money to invest in them

Management Involvement: Management involvement consists of the course instructor acting in the position of product manager or product owner (in Agile Scrum Software Development Terms). The instructor is involved heavily in providing the right amount of structure, in forming groups to encourage innovation, and

Resources: The largest resource provided to the students is the mentor who provides expertise in the areas of information technology tools, processes, and market research. The mentor also provides access to potential customers and investors who could provide further feedback, funding and resources for the project

4. Course Description

The course that encapsulates these principles is called "Applied IT Innovation". It consists of multiple teaching methodologies that include lecture, guest speakers, weekly standup meetings, etc. The defining feature is that students generate their own idea for a project, self-select into teams and them use Agile software development to create a minimally viable product. On the second day of class, each student was required to deliver an 80 Word Idea pitch presentation to the class. The students briefly explained their interest and confidence in developing the product. Students then formed into teams around the product ideas that were considered by the class to be most interesting, viable and

innovative.. Each student was also required to have a personal interview with the instructor to help the student to orient themselves within the IT innovation degree, and gave them the opportunity to air any concerns. It also allowed for direct mentoring of the students based on their concerns, abilities and perceptions.

Team Project The centerpiece of the course is the team project. The goal of the project is to create a minimally viable product—a product capable of being deployed to a subset of customers for evaluation. The goal of a minimally viable product is to enable a product development team to learn the most about the customer (through feedback) with the least amount of money spent. The customers targeted are usually early adopters who are more forgiving, and more able to understand the purpose of the product. See http://venturehacks.com/articles/minimum-viable-product for a definition of a minimally viable product. All projects require utilization of information technology as part of the product delivery. These often include the development of web applications or mobile applications. In order to create the minimum viable IT product, each student team created an initial backlog of user stories with input and mentoring from the instructor to assure that students were thinking about key issues of the project. There were four sprints during the semester—each 3 weeks long. With each initial sprint, there was a retrospective and review and the teams were expected to deliver working software. At the end of each sprint, each team presented a retrospective, detailing the results of their efforts during the previous sprint. A burn down chart representing the progressive completion and they talked about team, process, and technical risks, and laid out a plan for remediation in the next sprint..

At the end of the semester, students present their final product in a demonstration and presentation, which highlights the lessons learned, and other developments as team worked towards the development of the product. Each team presented a formal pitch of their presentation idea to venture capitalists. Two of the teams received term sheets for actual investment ranging from $25,000 to $50,000.

Market Research-Students are required to do initial market research to determine the need for their product. Market research can include the search for other similar products, as well as contacting potential customers to establish need.

5. Data Collection Method

In Section 3, we argued why our utilization of Agile Software Development in an IT innovation course would provide an environment where innovation could occur, and, most importantly, where entrepreneurial skills and attributes can be developed. We present some evidence of the changed attitudes and increased skills of the students who participated in the course. This evidence includes quantitative and qualitative perceptions of students about the development of IT innovations, about themselves, and about the course. We also briefly describe the quality of the resulting products produced by each of the student teams..

Free Response and Scaled Response Questionnaire

At the end of the course, a questionnaire was given to each member of the course, containing free response and scaled response items to provide for a quantitative and qualitative analysis of student's perceptions of the course and themselves in relation to the development of an innovative IT product.

All of the scaled response questions were administered after the qualitative response so that the students were not biased to respond to free response questions using the concepts in the scaled response section. The questions used are reported in the analysis section in conjunction with the reported results.

6. Analysis and Results

6.1 Qualitative Analysis Method

The qualitative responses were coded for themes by one of the authors. Substantially distinct categories emerged such as those which focused either on technical expertise—mentioning coding, programming languages) or marketing expertise (doing market research), general project management (time / coordination concerns), and team related concerns (team dynamics, getting along, social loafing). An Agile software development category was developed to capture any comment which mentioned an Agile software development practice (iterative development, standup meetings, etc.). Students could respond with multiple answers to each question. Each response was categorized separately.

6.2 Qualitative Analysis Results

We asked students which challenges they perceived in developing a new IT product, and how the characteristics of the course addressed those challenges. Understanding student's perceptions of challenges, and how these challenges were overcome through participation in the course gives us some insight into how students develop confidence in their innovative product development abilities.

We report here the proportion of students which responded with a certain category

What were your greatest concerns related to your own abilities to deliver your team's project idea when

you began the project? Think of two or three concerns and describe each concern in a sentence.

- 64% voiced concerns about their own technical skills
- 36% mentioned project management concerns-could the project be completed on time
- 36% raised team concerns related to getting along with the team and the efforts of other team members.
- 28% related to the specific idea for the product.

What aspects of the course improved your ability to develop an innovative product?

- 50% cited the Agile software development process
- 42% cited contact with business people
- 14% cited course environment
- 14% cited presentations given to customers

What do you feel have been your greatest improvements in your ability to contribute to the delivery of an innovative product? Think of two or three improvements

- 43% cited technical skills
- 36% cited time management/task management skills (at least one per team)
- 29% cited scoping skills
- 29% cited teamwork skills
- 21% Students cited working with customer skills

What were your greatest concerns about working on a team at the beginning of the project? Think of two or three concerns.

- 43% concerned with other group member's efforts
- 43% Students concerned with getting along with other group members
- 28% Students concerned with coordination (meeting, staying focused).
- 21% cited differences in technical skills

What aspects of the course improved your team skills?

- 57% cited Agile development practices.
- 29% cited open-endedness of course
- 29% cited self-selecting teams
- 14% cited feedback from other team members

6.3 Quantitative Analysis and Results

Students were asked at the end of the course to rate different perceptions of their abilities. The quantitative analysis results are based off of the results of a two-tailed T-Test comparing the mean scores for the start and end of the semester for each question. The sample size for these results is n=14.

The results of the analysis are reported in Table 1 below.

Following this questionnaire, students were asked to rate the extent to which course characteristics influenced their improvements. The results of this data analysis are reported in Table 2:

	Mean	SD
Iterative Development	8.72	.91
User Stories Requirements Documentation	7.27	1.48
Standup Meetings	7.18	1.32
Mentoring	8.72	1.35
Self-Assigned Teams	8.27	1.35

Table 2: Importance of Course Characteristics Results

	Semester Start		Semester End			
	Mean	S.D.	Mean	S.D	Dif	Sig.
My confidence in my ability to contribute to the delivery of a working version of a new product	6.17	1.70	8.00	1.60	1.83	0.0070
My ability understand and clearly define a problem the product needs to be able to solve	7.25	1.86	8.58	1.24	1.33	0.0300
My ability to estimate the amount of effort and resources needed to complete a software project	5.50	2.71	7.25	1.14	1.75	0.0340
My ability to break down work into smaller tasks	5.58	2.02	7.92	1.44	2.33	0.0008
My ability to communicate concerns and suggestions to others	7.00	1.35	8.75	0.62	1.75	0.0002
My ability to coordinate my efforts with others	6.25	1.54	7.33	1.61	1.08	0.0800

Table 1: Perceptions of Confidence and Skills Results

6.4 Product Quality Results

There were four product teams in total, resulting in four products: a website for connecting language learners in a local metropolis area, a mobile app side scrolling game, an app for recording cow pregnancy tests, and an app for identifying allergens in foods.

Perhaps the most important measure of the quality of the product is the reception of the market to the development of the product.

Two products resulted in actual capital being awarded by venture capitalists: one for $50,000 and one for $20,000.

According to the instructor's viewpoint, each project could be considered a successful minimally viable project.

7. Discussion of Results

The goal of this class was to foster entrepreneurship in IT students by using several different pedagogical techniques to help them develop an innovative product. Students perceived an increase in their ability to develop innovative products, along with several other supporting skills such as problem definition, project management, and team relationship. Each team developed a quality product, some of them attracting the attention of investors. Many of the skills learned in this course could have been learned in another experiential course. However, half the class attributed improvements in their individual abilities to develop an innovative product to the use of Agile software development practices. Agile software development practices were also attributed for the development of team skills.

The improvement in team skills should not be a surprise, given that students were probably more accountable to each other, met more often, and discussed work in more detail than they would have in other courses. User story development, sprint planning sessions, and weekly standup meetings all led to this.

The improvement in innovation skills likely came from the increased flexibility of the Agile software development process, especially when the student's idea was less defined. Most of the students who mentioned Agile were from the same team—the team that created a video game. The idea for the game had to be refined (especially with respect to scope issues) over time. The iterative nature of the Agile process could be acting as a reality check for creative ideas, allowing them to be turned into real products through the limitation of scope.

8. Lessons Learned

One of the critical lessons learned in developing entrepreneurial skills is to let the students practice entrepreneurship. The students must be allowed to lead and risk in the classroom setting. Allowing the students to define the work in the class and to evaluate the work products gives students the opportunity to lead the creative process. In this class, we found that with ownership, comes effort. Students took the initiative to learn outside skills and to make connections on their own related to their projects that were not suggested or encouraged by the instructor. In other words, the students believed in their ideas and sought to advance them not just for the class, but also for the sake of the idea itself. For example, one student contacted a prominent trade magazine to get an article printed promoting their idea. Another team learned a new programing language and framework to aid in the development of their product.

A second lesson learned is that some structure is needed, but it must be structure around the students' ideas. All aspects of the class were in context of the students' goals and objectives for their projects. So the agile methodology, and almost all of the assignments were geared to advancing the students' idea and agenda. This paradigm of structure around the students led to projects that are richer and more interesting. Agile software development allowed for the appropriate amount of flexibility and structure to accomplish this end.

Third, the students were able to create value in a short period of time. Two projects received term sheets for investment in their ideas. This external market validation shows that these were successful student initiated projects.

Mentoring is a critical part of this process. By allowing the students to define the work and projects, the instructor became mentor and coach. It required both accountability and guidance to move them through this process. Mentoring consisted of offering technical guidance, team dynamics assistance, and process help. The mentoring role helped the students lead and grow.

Finally, it was fun. The students learned and loved the class. The ideas were novel and valuable and the interactions were connected to real-world problems. The course had meaning because the students were advancing their own ideas. Everyone felt invested in the ideas because they were original and they had selected to work on them. This lead to a rich and full class and projects that live beyond the class itself.

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