Creation of a Class to Teach Software Entrepreneurship

Dr. Jeremy Straub, North Dakota State University

Jeremy Straub is the Director of the NDSU Institute for Cyber Security Education and Research and an Assistant Professor in the Department of Computer Science at the North Dakota State University. He holds a Ph.D. in Scientific Computing, an M.S. and an M.B.A. and has published over 40 journal articles and over 120 full conference papers, in addition to making numerous other conference presentations. Straub's research spans the gauntlet between technology, commercialization and technology policy. In particular, his research has recently focused on cybersecurity topics including intrusion detection and forensics, robotic command and control, aerospace command and 3D printing quality assurance. Straub is a member of Sigma Xi, the AAAS, the AIAA and several other technical societies, he has also served as a track or session chair for numerous conferences.

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Abstract

This paper presents the design and implementation of a class for teaching software entrepreneurship. The class focused on teaching students the basics entrepreneurial venture development and how these processes relate, specifically, to a software venture. This paper presents the overall instructional plan of the course and discusses each of the course's components. The implementation of the project component is discussed, in particular, in detail. The design and implementation challenges that were encountered are discussed.

This course was run in Spring of 2020 and started as an in-classroom course, later transitioning to an online course due to the COVID-19 pandemic. The outcomes of the course are discussed. Possible future enhancements are considered.

1. Introduction

Software businesses have been responsible for tremendous growth and changes in society. Once small startups, names like Google, Microsoft, PayPal and Facebook now are among the world's best known and most valuable companies. Many software companies are started by university students, though only a select few grow into multinational successes. A software entrepreneurship course was developed to help prepare prospective student software entrepreneurs. This paper presents the design and implementation of this course.

The class focused on teaching students the basics of a model for entrepreneurial venture development and how these processes relate, specifically, to a software venture. It included traditional lecture-style content delivery, online discussion boards, online quizzes and a course-long entrepreneurial project. For the project component, students broke into groups of four to five individuals. Each group developed a software venture concept, based on the identification of a need and the interests of the group members. The groups conducted customer discovery exercises, developed a conceptual minimum acceptable product and a produced and evaluated a business plan for the venture.

This paper presents the overall instructional plan of the course and discusses each of the course's components. The implementation of the project component is discussed, in particular, in detail. The design and implementation challenges that were encountered are discussed.

This course was run in Spring of 2020 and started as an in-classroom course with a synchronous distance participation option and students begun with in-person interactions. They were able to conduct in-person customer discovery exercises in the local community. However, due to the COVID-19 pandemic, the course transitioned to an online model mid-way through. Because of this, the paper includes a discussion of the differences between the planned implementation and the actual implementation. The challenges of the transition and rapidly converting to online delivery are discussed. Further, the paper discusses how a software entrepreneurship could operate under either the online or in-person model, based on this experience.

The outcomes of the course are discussed. Possible future enhancements are considered.

2. Background

Bechard and Gregoire [1] trace entrepreneurship education back to at least 1984, though elements of entrepreneurship undoubtedly were taught prior to this. In fact, entrepreneurships education, like experiential education, can likely trace its roots back to apprenticeships, where apprentices learned both the skills and the trade that they apprenticed in [2]. In many cases, the expectation of such an apprenticeship would clearly be that the apprentice would leave and start their own practice, an entrepreneurial activity, as a small town or village could need only a single craftsman of a given trade. While this would satisfy the definition of an entrepreneur as "a person who organizes and manages any enterprise, especially a business, usually with considerable initiative and risk" [3], modern perceptions of entrepreneurship typically include an aspiration of growth.

Clearly, there is great benefit to entrepreneurial activities. Kuratko contended, in 2005, that "entrepreneurship has emerged over the last two decades as arguably the most potent economic force the world has ever experienced" [4]. The benefit is not just economic as small enterprises are responsible for two-thirds of inventions [4], making entrepreneurship responsible for scientific and engineering advances, as well.

Pittaway and Cope [5] note that there is a "lack of consensus" on a definition of what entrepreneurship includes and what forms it takes. Despite this, they note a positive impact of the field on "student propensity and intentionality," though they were unable to assess exactly what entrepreneurial outcomes are produced. Others [6], [7] note similar concerns with outcome assessment due to methodological issues with studies, metrics used for assessment [8] and other factors. Vanevenhoven [9], in his self-described "call for mutiny," suggests that entrepreneurship education must "kick students out of the classroom" and "into the actual environments that they are studying".

However, not all entrepreneurial education works. Matlay [10] identified issues between some programs' outcomes and graduates' skill needs. Studies have also identified negative correlation between participation in entrepreneurial activities [11] and studies [12] and entrepreneurial intent. Others [11], [13], though, have found a positive correlation between studying entrepreneurship and entrepreneurial intent. Also, while Oosterbeek, Praag and Ijsselstein [12] also found minimal enhancement of students' entrepreneurial skills at the program they studied, others [14] have found that not to be the case. In fact, the comparison of Oosterbeek, Praag and Ijsselstein's work [12] and other studies suggests that the quality of entrepreneurial education and entrepreneurial intent may be linked. Martin, McNally and Kay [15] note that this entrepreneurship-outcome relationship is "stronger" for academic programs than "training-focused" ones. Walter and Block [13] note the particular value of educational activities for increasing entrepreneurship in "entrepreneurship-hostile" environments.

Approaches to entrepreneurial education that use student-centered learning methodologies [16], experiential education techniques [17] and groups [17] or teams [18]. While entrepreneurship education has been studied extensively in the context of business disciplines and in various

engineering disciplines [19], there is limited prior work in the computer science discipline and in software development, despite the prevalence of entrepreneurial activities in these fields outside of academia. Doboli, et al. [20] describe the computer science and engineering entrepreneurial components at Hofstra University, which include both the inclusion of entrepreneurial content modules in core courses and the opportunity for students to have a more in-depth experience. Winkler, et al. [21] discuss how entrepreneurship was included in a particular e-commerce course through the use of a "virtual enterprise" simulation system.

3. Class Overview and Goals

The goals of the course were for students to learn foundational skills for starting a software technology business (entrepreneurship) or new software product development unit within an existing business (intrepreneurship). Key areas of study for the course included opportunity assessment, software intellectual property and protection techniques, product development basics, marketing, team building and management skills. Students were also expected to learn how business and entrepreneurial models and workflows interacted with software lifecycle models and to apply the skills they learned to a software technology and business venture concept.

To this end, the course consisted of several key areas of student participation. The primary delivery of new content was via a combination of course lectures and readings in *Launching New Ventures: An Entrepreneurial Approach* from Cengage. These readings were augmented with a discussion of the relationship between the business concepts presented in the book and software development processes and the application of these concepts to software-related entrepreneurship. Additionally, the content was occasionally augmented with discussions of how the concepts would apply differently to an intrepreneurship (new venture within an existing business or entity) than to a startup company.

Discussion board posts, quizzes and worksheets were used to assess student understanding of the material that was presented and its application. Additionally, students learned venture implementation details and about the application of the material through a course-long software entrepreneurship project and a patent project. Each of these areas is described in more detail in subsequent sections.

While this course was designed to be conducted in person, the COVID-19 pandemic necessitated that it transition to being conducted online during the first semester that it was offered, Spring of 2020. As noted by Liguori and Winkler [22], the pandemic was particularly problematic for entrepreneurship education, due to the types of activities that are typically included in entrepreneurship courses. The adaptation of this course to the COVID-19 pandemic is discussed in Section 8.

4. Content Presentation

The primary content presentation portion of the course was relatively conventional. Material from the Cengage textbook *Launching New Ventures: An Entrepreneurial Approach* was utilized. The content that students read in the textbook and were presented via lectures were

augmented with discussions of the relationship between the business concepts and software development processes. Additionally, the book's online component provided a business plan template that student groups could use to help them with their business planning processes and related support materials.

The presentation of the entrepreneurship business content to students in lectures also frequently featured opportunities for students to discuss how the concepts applied to either their group projects or existing software-related businesses. In some cases, where significant differences exist, how the presented concepts would apply differently to an intrepreneurship (new venture within an existing business or entity) than to a startup company was also discussed.

In addition to the material from the aforementioned textbook, a number of supplementary materials were identified for students to read or watch. Several "Startup Story" presentations were identified for student viewing, which are listed in Table 1. Students were also asked to review six videos on the Lean Launchpad model, which are used as part of the NSF's I-Corps program. These videos, along with a link for additional videos which was provided to students who wanted to learn more, are listed in Table 2. Students were also directed to several resources (in addition to the textbook) for business plan creation. These are listed in Table 3. An instructor-created business plan outline, loosely based on the textbook, was also provided to students.

Table 1. "Startup Stories" Links

Material	URL
Android - Andy Rubin Startup Story	https://www.youtube.com/watch?v=K3fzL60G008
OnePlus	https://www.youtube.com/watch?v=269PQ94KnSw
Startup Stories YouTube Channel	https://www.youtube.com/channel/UCnyQy0wD_LCZTlyFHnKIS7Q/videos
Amazon Web Services Stories	https://aws.amazon.com/blogs/startups/25-startup-stories-from-25-entrepreneurial-founders/
Microsoft Alumni Startup Stories	https://www.microsoftalumni.com/s/1769/19/interior.aspx?pgid=1969&gid=2&cid=8024

Table 2. Lean Launchpad Video Links

Material	URL
Planning Customer Discovery – Part 1	https://vimeo.com/groups/204136/videos/75308828
Planning Customer Discovery – Part 2	http://vimeo.com/groups/204136/videos/75184102
Planning Customer Discovery – Part 3	http://vimeo.com/groups/204136/videos/75603393
Interviews – Part 1	http://vimeo.com/groups/204136/videos/75535337
Interviews – Part 2	http://vimeo.com/groups/204136/videos/76172223
Interviews – Right Questions	http://vimeo.com/74338298
More Videos & Other Materials	https://venturewell.org/i-corps/team-materials/

Table 3. Business Plan Resources

Material	URL
Inc Magazine Business Plan Templates	https://www.inc.com/larry-kim/top-10-business-plan-templates-you-can-download-free.html
SCORE Business Plan Templates	https://www.score.org/resource/business-plan-template-startup-business
Small Business Administration Business Plan Templates	https://www.sba.gov/business-guide/plan-your-business/write-your-business-plan

5. Course-Long Software Entrepreneurship Project

The course-long software entrepreneurship project was the showpiece feature of the software entrepreneurship course. During the project, students developed the concept of and a business and software/technology plan for a prospective venture. The venture concept was allowed to be either an entrepreneurial one (i.e., a startup) or an intrepreneurial one (venture within an existing firm); however, all of the teams chose to pursue a startup concept. The project went through four key phases, which are described in this section: customer discovery, business model development, business model analysis and product design.

5.1. Customer Discovery

Customer discovery is an often overlooked part of developing and refining a business model and assessing whether a business concept makes sense. The process is a key part of the NSF I-Corps Program (see [23]–[26]) and has been previously used with undergraduate students [27]. The process involves several key steps. First, key questions about customer needs related to the product concept or need area must be identified. These questions provide a rough outline for what team members should ask during interviews; however, the goal is to elicit information from the customer about what their needs and desires are, related to the product, so the interviews are necessarily and intentionally free form.

Then, interviews are conducted with potential customers for the product concept. Ideally, if the product may serve different constituencies, customers across all potential groups are interviewed. Again, the idea is to determine whether there is an actual need for the product – not to convince a potential customer of the need for (or to buy) the product.

Finally, the results from these interviews are analyzed to ascertain what needs exist and whether there may be different related product needs between groups. The outcome from customer discovery could be to validate the need for the product, to refine the product concept or even to determine that the product is unneeded.

Students followed these steps. They developed an initial interview outline to ascertain whether customer need for a product like their concept existed and what features this product would have. They then refined this questionnaire through in-class practice interviewing other students who pretended to be potential customers. Next, they interviewed individuals in the real world (explaining that they were doing the interviews for a class project and not necessarily starting a

venture). Finally, they analyzed the interviews and refined their product concept and feature set based on what they had learned. Several worksheets were created for this purpose and the completed worksheets were submitted for assessment, as discussed in Section 7.3.

5.2. Business Model Development

Business model development flowed logically from the customer discovery exercises. During the business model development process, students answered key questions about how their venture concept would work. This process started towards the end of the time period where customer discovery was being considered and went on throughout much of the rest of the semester. It also was worked on concurrently with the technical design of the prospective product.

Key questions that the student teams answered related to how the business would make money, including who its customers would be and what they would specifically pay for. Student teams considered multiple business models used for software products including software license sales, in-app purchases, and advertising revenue. Teams also considered how the product would be marketed and who their initial and later-phase customers would be. Questions about business finance, leadership and other key business plan topics were also answered.

Students were given an instructor-created business plan outline. They also had an outline and sample responses provided in the textbook and were provided links to several other online business plan resources (see Table 3 in Section 4). Students also had online access to software which came along with the book that they could use to help generate the business plan, section by section. Perhaps most notably, most of the concepts covered throughout the course (in lectures, through readings and through other materials) were directly inherently responsive to a business plan section.

Students had several meetings with the instructor, throughout the semester, to discuss their business plan and get feedback. They then analyzed it (analysis was ongoing throughout the development process; however, teams were asked to conduct a final analysis before submission) and submitted it for assessment.

5.3. Business Model Analysis

Business model analysis is critical to business plan development and refinement. The student teams were asked to analyze their business plan throughout the development process and throughout the course. This analysis was based on three sets of inputs. First, teams were encouraged to refine their business plan based on what they learned from customer discovery and research into the business environment (see Section 7.3 for a brief discussion of worksheets that helped student teams conduct business environment analysis). Second, teams inherently refined parts of their business plan as topics were covered in lectures (and corresponding quizzes and other assignments). Finally, teams were asked to refine their business plan based on what they learned from their software design planning process. The outputs of business model (and plan) analysis were updates to the busines plan, refining it until the final version that was submitted for assessment was produced.

5.4. Product Design

The last key component of the course-long project was the software product design. This component used what students were already familiar with regarding software design and development and the software lifecycle to develop a product concept and a design for the product. Teams were not asked to actually develop the software; however, they were asked to make key design decisions, wire frame diagrams and other high-level design documents. They were also asked to identify key areas of technical risk and to research those. Finally, they were asked to identify the key technology or technologies that they would need to develop to make their product successful, based upon product need and the lack of an existing solution.

Teams wrote up their software design, presented it to the instructor informally and submitted it for assessment. They also selected one of the key technologies that they identified to use for the patent project, which is described in Section 6.

6. Patent Project

To help the students learn about the value of intellectual property and the process of protecting it, students participated in a short patent project. This project asked each group to identify one core piece of intellectual property that was included in their design, would be needed or could be valuable for their venture. Then the group went through the process of compiling a lightweight version of the information that would be included in a patent application for the identified intellectual property, similar to how an inventor might prepare an invention disclosure to provide to a patent attorney.

Key components of this project included identifying prior work in or close to the area of the innovation and explaining how the innovation was different from this prior work, identifying what the 'claimed' innovation was (which would translate into the claims of the patent), and describing the innovation in a way that would be accessible to a less technical reader. Students were provided access to copies of the book *Patent It Yourself* from Nolo Press to use as a reference; however, this access was somewhat limited by the pandemic, as only a single copy of the book had been purchased for each group, making access challenging when students left campus.

7. Assessment

Four forms of assessment activities were utilized: discussion boards, quizzes, worksheets and assignments and project components. Each is now discussed.

7.1. Discussion Boards

A number of discussion board assignments were created for use in this course. Due to increased pressures on students and the increased time needed for coordination for the group projects, some of these were not used due to the need to reduce student workload during the semester. However, all of the discussion board assignments are included for potential use (or piggybacking

off of) by others in the future. The topic posts have been edited slightly to remove dates or day references, to be more generic and useful by others in the future, and for clarity. These posts are presented in Table 4. Article lists for posts 3 to 10 are also provided in Tables 5 to 12. The article lists have been updated with a limited number of newer articles in preparation for the next offering of this course.

Table 4. Discussion Board Topics.

Assignment #	Discussion Board Topic
1	What concerns do you have about an entrepreneurial venture, given what you have learned in this chapter? What could society do to make it easier to start new ventures?
2	This week, we'll focus on startup stories. These are stories about startup businesses that have (typically) been successful and advanced from an early stage to a late-stage startup (or later). A folder of startup story links can be found under course content. Please watch the Android and OnePlus startup stories. Please pick another startup story, either from the YouTube channel or one of the other links. Please answer the last three questions for the three startup stories (Android, OnePlus and your selection). Please provide the link to the startup story you selected and briefly describe it. What is the key technological innovation of each firm (if any)? What is the key business innovation of each firm (if any)? Is each company's success driven by the technological innovation, the business innovation, both, or something else?
3	Please read one of the below articles on the benefits of entrepreneurship. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
4	Please read one of the below articles on entrepreneurship & diversity. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
5	Please read one of the below articles on youth, education and entrepreneurship. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
6	Please read one of the below articles on being an entrepreneur. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].

7	Please read one of the below articles on entrepreneurship helping. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
8	Please read one of the below articles on entrepreneurship considerations. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
9	Please read one of the below articles on entrepreneurship around the world. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
10	Please read one of the below articles on entrepreneurship and society. Please summarize the article and what you have learned from it. Please make this post by [date]. Then respond to two of your classmates' posts. Please make these response posts by [date].
Topic Selection	Our goal, in this thread, is to determine what the topics we will use for the patent application and business plan assignments. For those in class, you've had a chance to present your topic a few times. Please make a concise (~3 sentences) presentation of your topic explaining what it is, who it would serve and what its source of innovation is. Please feel free to ask questions about others' topics or to suggest enhancements or changes.

Table 5. Benefits of Entrepreneurship Articles.

Article	URL
Gaotlhobogwe & Du Toit - Why kids should be taught how to start a business at school	https://theconversation.com/why-kids-should-be-taught-how-to-start-a-business-at-school-90557
Powers & Loarne-Lemaire - What comes after the lemonade stand? Fuelling self-efficacy and intentions in our next generation of entrepreneurs	https://theconversation.com/what-comes-after-the-lemonade-stand-fuelling-self-efficacy-and-intentions-in-our-next-generation-of-entrepreneurs-85263
Kunert & Cullis - Universities must teach their budding scientists entrepreneurship	https://theconversation.com/universities-must-teach-their-budding-scientists-entrepreneurship-121388

Table 6. Entrepreneurship and Diversity Articles.

Article	URL
Jones & Kim - Most successful entrepreneurs are older than you think	https://theconversation.com/most-successful-entrepreneurs-are-older-than-you-think-95402
Thebaud - How the myth of 'lone warrior' entrepreneurs penalizes women	https://theconversation.com/how-the-myth-of-lone-warrior-entrepreneurs-penalizes-women-38473

Article	URL
Bone - How business support can boost startup diversity in uncertain times	https://theconversation.com/how-business-support-can-boost-startup-diversity-in-uncertain-times-132615
Vats - The iconic American inventor is still a white male – and that's an obstacle to race and gender inclusion	https://theconversation.com/the-iconic-american-inventor-is-still-a-white-male-and-thats-an-obstacle-to-race-and-gender-inclusion-145372

Table 7. Youth, Education and Entrepreneurship Articles.

Article	URL
Schmitt - Understanding youth entrepreneurship in light of ecosystems	https://theconversation.com/understanding-youth-entrepreneurship-in-light-of-ecosystems-83856
Bonnici - Africa must do more to harness young people's entrepreneurial drive	https://theconversation.com/africa-must-do-more-to-harness-young-peoples-entrepreneurial-drive-63774
Salmon - Forget The Apprentice, where are all the young entrepreneurs?	https://theconversation.com/forget-the-apprentice-where-are-all-the-young-entrepreneurs-86190
Pathak - How to future proof university graduates	https://theconversation.com/how-to-future-proof-university-graduates-48639
Barron - Gen Z entrepreneurs view higher education as vital to their startups	https://theconversation.com/gen-z-entrepreneurs-view-higher-education-as-vital-to-their-startups-108645
Mayhew & Selznick - Straight A students may not be the best innovators	https://theconversation.com/straight-a-students-may-not-be-the-best-innovators-54440

Table 8. Being an Entrepreneur Articles.

Article	URL
Bernard - Self-efficacy, desirability, feasibility… key concepts for entrepreneurship	https://theconversation.com/self-efficacy-desirability-feasibility-key-concepts-for-entrepreneurship-75269
Arreola - I am scared to my bones to… become an entrepreneur	https://theconversation.com/i-am-scared-to-my-bones-to-become-an-entrepreneur-105922
Spicer - 'Fail early, fail often' mantra forgets entrepreneurs fail to learn	https://theconversation.com/fail-early-fail-often-mantra-forgets-entrepreneurs-fail-to-learn-51998
Stephan - How entrepreneurs have the most stressful – yet most satisfying – jobs	https://theconversation.com/how-entrepreneurs-have-the-most-stressful-yet-most-satisfying-jobs-95018

Table 9. Entrepreneurship Helping Articles.

Article	URL

Article	URL
Ormiston - Refugees are helping others in their situation as social entrepreneurs	https://theconversation.com/refugees-are-helping-others-in-their-situation-as-social-entrepreneurs-80475
Chalkley - How entrepreneurship can bring people off benefits – if they're given a chance	https://theconversation.com/how-entrepreneurship-can-bring-people-off-benefits-if-theyre-given-a-chance-74499
Richey - 'The asylum process broke my dream … now I have a new one.' The refugee entrepreneurs	https://theconversation.com/the-asylum-process-broke-my-dream-now-i-have-a-new-one-the-refugee-entrepreneurs-146234
Rebmann & Stephan - How entrepreneurial skills can equip young people facing the bleak prospect of unemployment	https://theconversation.com/how-entrepreneurial-skills-can-equip-young-people-facing-the-bleak-prospect-of-unemployment-155325

Table 10. Entrepreneurship Considerations Articles.

Article	URL
Dawson & de Meza - Why optimism and entrepreneurship are not always a good mix for business	https://theconversation.com/why-optimism-and-entrepreneurship-are-not-always-a-good-mix-for-business-101417
Wilcock - Why fast failures make US startups a better bet than those in the UK	https://theconversation.com/why-fast-failures-make-us-startups-a-better-bet-than-those-in-the-uk-53067
Wright - The right support can help scientists turn their best ideas into businesses	https://theconversation.com/the-right-support-can-help-scientists-turn-their-best-ideas-into-businesses-62245

Table 11. Entrepreneurship Around the World Articles.

Article	URL
Boone - Why some counties are powerhouses for innovation	https://theconversation.com/why-some-counties-are-powerhouses-for-innovation-111040
Prashantham - When globalisation meets entrepreneurship it can be a force for good	https://theconversation.com/when-globalisation-meets-entrepreneurship-it-can-be-a-force-for-good-64415
Gherhes, Brooks & Vorley - How entrepreneurship offers a route out of industrial decline	https://theconversation.com/how-entrepreneurship-offers-a-route-out-of-industrial-decline-118629
Swana - How Africa can instil entrepreneurship as a tool of development	https://theconversation.com/how-africa-can-instil-entrepreneurship-as-a-tool-of-development-47393
Hanoteau & Vial - 'Making Indonesia 4.0' and supporting digital startups is good, but what about the small low-tech entrepreneurs?	https://theconversation.com/making-indonesia-4-0-and-supporting-digital-startups-is-good-but-what-about-the-small-low-tech-entrepreneurs-93863

Article	URL
Shrivastava - How women entrepreneurs are changing Indian society	https://theconversation.com/how-women-entrepreneurs-are-changing-indian-society-122352
Arreola - France, the land of entrepreneurs…	https://theconversation.com/france-the-land-of-entrepreneurs-102962

Table 12. Entrepreneurship and Society Articles.

Article	URL
Scott-Kemmis - If we want to promote innovation we need to focus on businesses	https://theconversation.com/if-we-want-to-promote-innovation-we-need-to-focus-on-businesses-49229
Dembek - Entrepreneurs can help bring new thinking to manufacturing	https://theconversation.com/entrepreneurs-can-help-bring-new-thinking-to-manufacturing-32368
Villette - 'Start-up nation': a symptom, but of what?	https://theconversation.com/start-up-nation-a-symptom-but-of-what-108007
Mazzarol - Entrepreneurial ecosystems and the role of government policy	https://theconversation.com/entrepreneurial-ecosystems-and-the-role-of-government-policy-35809
Soleas - A wolf in sheep's clothing: Disruption is overrated in terms of innovation	https://theconversation.com/a-wolf-in-sheeps-clothing-disruption-is-overrated-in-terms-of-innovation-106986
Mason & Hruskova - It takes an ecosystem to raise a successful start-up	https://theconversation.com/it-takes-an-ecosystem-to-raise-a-successful-start-up-125118
Naudé - The surprising decline of entrepreneurship and innovation in the West	https://theconversation.com/the-surprising-decline-of-entrepreneurship-and-innovation-in-the-west-124552
Zuckerman - Can innovators build a future that's both disruptive and just?	https://theconversation.com/can-innovators-build-a-future-thats-both-disruptive-and-just-49871

7.2. Quizzes

The course included four quizzes that were assigned to students roughly evenly throughout the semester. Each quiz covered three to four units of material and focused on material recall and application. The primary goal and benefit of the quizzes was to encourage students to focus on lectures and to read the assigned materials in the textbook.

7.3. Worksheets

Several instructor-created worksheets were assigned to students for them to gain practice in particular areas. Worksheets were developed for customer discovery, business plan creation and for capturing patent-relevant technology details.

A customer discovery worksheet was created for students to practice customer discovery script development and to develop the customer discovery script for their course-long project (see Section 5.1 for more details). Worksheets were also provided to practice the customer interview process and to conduct the actual customer discovery interviews.

A template and worksheet for business plan creation were created by the instructor to aid students in developing a business plan for their venture. This template and worksheet were also used in class to practice the process of business plan development. A second worksheet was used to help each group identify what each group member's perspective on the venture was. It asked students to answer five key questions about the venture, including identifying the mission, customers and desired results. Students within each team were asked to compare the worksheets to see if group members' expectations were aligned and to develop a shared mission, goals and plan.

Worksheets were also developed for student pre-course entrepreneurial goal self-assessment, analyzing the industry that each team was focusing on, developing an elevator pitch, analyzing venture feasibility, analyzing the impact of the five forces, project planning and SWOT analysis. Most of these worksheets were done in-class (either in-person or virtually) but could be finished after class, if more time was needed.

7.4. Project Components

Three key deliverables from the course project were key elements of assessment: the business plan, the technical writeup and the patent project writeup. The course project is described in more detail in Section 5; however, the assessed elements are described in this section.

The business plan could be completed whatever form the team preferred, based on the instructor-provided sample outline or the example outlines from SCORE, Inc Magazine and the Small Business Administration which were provided.

The technical writeup was also an open form document. Students were asked to describe the software system and technologies that their system was based on. This writeup was basically a limited-scope, high-level software development plan for the group's system.

The patent project writeup, for most groups, drew heavily from the technical writeup. For the patent project writeup, each group was asked to describe their key technology (or one of their key technologies, if they had identified more than one) and summarize key details that would be needed for a patent application. Groups were asked to look for prior patents or other work that might be a barrier to patentability, to describe the technology and its functionality and to identify what would be claimed in a patent application.

8. Adapting to the Pandemic

This course was designed primarily for in-person delivery, though it was setup for synchronous participation by remote students from the beginning of the semester. Given this, the course

already had many of the elements that were required for it to continue with minimal disruption after campus closed in response to the COVID-19 pandemic at spring break.

Several things made the completion of the course in a manner similar to what was initially planned possible. First, the students had already conducted the customer discovery exercises at the point that campus closed down. This would have been very difficult to conduct without the ability for the students to visit with prospective customers in person. Also, the experience would have been somewhat different for the students. NSF I-Corps prefers in-person interviews to the greatest extent possible, due to these differences. While campus closure prior to completing customer discovery wouldn't necessarily have precluded the semester-long project, it likely would have delayed it and resulted in less useful customer discovery input.

Second, at the point campus closed, it was unclear how long the closure would be for (and initially announced as only a two-week closure to prevent post spring break COVID-19 spread). The decision to continue following the initial schedule (as opposed to delaying some elements until a prospective return-to-campus date) was also key to the successful completion of the course.

Third, all of the students had access to high-speed internet access. Because of this, it was possible to continue synchronous course meetings at the scheduled class meeting time and to have ad hoc meetings between the instructor and the teams.

Because of these factors, the impact of the pandemic on the course was somewhat limited. Some planned assignments and, in particular, discussion board assignments were removed due to the extra stress on students of the rapid change to remote studying. The focus on the group project provided students with peer interaction opportunities that were highly sought after. The pandemic also impacted communications and collaboration, to some extent, within student project teams and between teams and the instructor.

Notably, the instructor offered a lecture specifically on how businesses adapt as the initial point of return from spring break into the pandemic-closed-campus environment. This was an additional learning opportunity for students regarding how businesses must adapt to changing circumstances. Each team was asked to think about how the pandemic would impact their business, if they were planning it for real or if it was already operating and these impacts were discussed.

9. Conclusions and Future Work

This paper has presented the design and implementation of a software entrepreneurship course that was offered at North Dakota State University (NDSU) during the Spring semester of 2020. It has described the need for this course and prior work on teaching entrepreneurship, including limited prior work within the computer science discipline.

The key components of the course have been described. These include the course-long software project, business plan project, technical design component and patent project.

As this course was offered during the semester that the NDSU campus closed mid-semester in response to the COVID-19 pandemic, the impact of the pandemic on the course was also briefly discussed. Fortunately, the impact was limited due to the point at which the pandemic caused the campus closure, relative to progress in the course, and design decisions that had already considered the need to support remote synchronous student participation.

Several areas of enhancement are planned for future offerings of this course. First, future offerings will use some of the materials that were not used to reduce student workload amidst the pandemic. Second, it is planned that the instructor will develop a sample business venture concept that will be developed throughout the semester in lockstep with the student project. This will serve as an example for the student projects as well as allow the project component to be tied in more directly with the lecture (as the sample project can be used as a consistent example throughout the course).

Acknowledgements

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