A Scalable Approach to Student Team Formation for Innovation Based Learning

Ryan Striker P.E., North Dakota State University

Ryan Striker is a life-long learner. Ryan has over a decade of professional experience designing embedded electronic hardware for industrial, military, medical, and automotive applications. Ryan is currently pursuing a PhD in Electrical and Computer Engineering at North Dakota State University. He previously earned his MS in Systems Engineering from the University of Saint Thomas and his BS in Electrical Engineering from the University of Minnesota.

Mr. Enrique Alvarez Vazquez, North Dakota State University

Experienced Systems Engineer with a demonstrated history of working in the electrical and electronic manufacturing field. Highly skilled in Embedded Devices, Software Engineering, and Electronics. Extremely motivated and self-reliant with a great believe in autonomy, new ways to solve problems and ROWE approaches. Team player and devoted to create superb working environments through dedication and team culture. Strong information technology professional with two MSc's and working on a Doctor of Philosophy - PhD focused in Electrical Engineering from North Dakota State University.

Mary Pearson, North Dakota State University

Mary is a Ph.D. candidate in biomedical engineering with research focused in the area of bioelectromagnetics, specifically designing electronics that can be used as medical devices. She obtained her B.S. and M.S. degrees at NDSU in electrical and computer engineering. Mary is also interested in STEM education research.

Ms. Lauren Singelmann, North Dakota State University

Lauren Singelmann is a Masters Student in Electrical and Computer Engineering at North Dakota State University. Her research interests are innovation-based-learning, educational data mining, and K-12 Outreach. She works for the NDSU College of Engineering as the K-12 Outreach Coordinator where she plans and organizes outreach activities and camps for students in the Fargo-Moorhead area.

Ms. Ellen M Swartz, North Dakota State University

Ellen Swartz is currently pursuing a M.S. degree in Biomedical Engineering at North Dakota State University. Her research interests include STEM education, innovation-based learning, agent-based modeling of complex adaptive systems, and bioelectromagnetics. She previously received her B.S. degree from North Dakota State University in Electrical and Computer Engineering.

A Scalable Approach to Student Team Formation for Innovation Based Learning

Ryan Striker
Department of Electrical and Computer Engineering
North Dakota State University
Fargo, ND
ryan.striker@ndsu.edu

Mary Pearson
Department of Electrical and Computer Engineering
North Dakota State University
Fargo, ND
mary.pearson@ndsu.edu

Ellen Swartz
Department of Electrical and Computer Engineering
North Dakota State University
Fargo, ND
ellen.swartz@ndsu.edu

Lauren Singelmann
Department of Electrical and Computer Engineering
North Dakota State University
Fargo, ND
lauren.n.singelmann@ndsu.edu

Enrique Alvarez Vazquez
Department of Electrical and Computer Engineering
North Dakota State University
Fargo, ND
enrique.vazquez@ndsu.edu

Abstract

We present a distributed, scalable, student-driven method for both defining a set of projects and subsequently assigning students to project teams. This process has been implemented within a mixed online/in-person multi-university course comprised of both undergraduate and graduate level students who are predominantly, but not exclusively, pursuing engineering degrees. Our Innovation Based Learning (IBL) course seeks to provide students with maximum freedom and responsibility for their own learning; we seek to radically rethink and reduce the organizational tasks normally performed by the instructor. Re-assigning these tasks to the students creates new opportunities to learn soft skills such as giving an elevator pitch, project management, market research, and online collaboration. Key technology enablers used in this process are: Flipgrid for sharing short videos, and a Slack channel for both one-to-one and group chat.

All projects are defined and proposed by the students. We teach market needs analysis, and jump-start student brainstorming, by requiring that each proposal relate to a Federal Funding Opportunity Announcement (FOA). Student-proposed projects also ensure that each semester's mix of projects addresses the unique set of backgrounds/interests of that student cohort. By increasing student autonomy in the formation of working groups, we increase student motivation for their topic and team. One concern with this distributed process is speed; will it take too long to crowd-source ideas and self-assemble teams? Using new digital platforms, individual student project proposals are created and reviewed entirely outside of class meeting times. Grouping students into teams is also a student-driven activity which requires minimal instructor intervention or in-class overhead. We will share considerations, surprises, and lessons-learned from this process as it has been employed and refined, over multiple years, within a multi-university IBL course. A step-by-step implementation guide is provided for others wishing to emulate the process.

Introduction

Central to our concept of IBL (Innovation Based Learning) are the values of freedom, transparency, and responsibility[2]–[6]. Each time that a classroom management task is delegated to the students, several benefits result. First, students feel greater ownership when given control over their tasks [7]. Next, the course becomes more scalable because workers and workload grow in tandem rather than accumulating for a single individual (the instructor). But, simple gains in instructional efficiency are not, and should not be, the primary motivation for shifting task responsibility to the students. Instead, we believe that more and better student learning results. As a new IBL cohort gathers and self-organizes, students learn how to: analyze customer needs, deliver a marketing pitch, develop a work breakdown structure, and create a project plan, all before they've even officially begun their semester project.

Challenges

In a traditional project-based course, projects are usually pre-defined by sponsors such as faculty, alumni, or local industry. Several milestone deliverable dates may be defined in advance, again by the instructor or project sponsor. Finally, these same overseers define the particular skillsets which a student team must possess.

The strength of the traditional model is the quality and timing of the project definitions; all projects are defined by experts before the semester begins. The weakness of the traditional model is two-fold. First, the traditional model requires significant time and thought from a team of experts; these are individuals whose time is both valuable and in-demand. To serve more students, a traditional course requires incrementally more experts and their time. Second, students cannot learn needs analysis, business proposal, and project planning skills if those tasks have been completed for them.

Elimination of the project sponsor role has immediate tangible benefits. Instructors have less project planning to do prior to the semester, and they do not need to recruit more project sponsors to match growing enrollment. Meanwhile, students will feel more motivated as they practice self-initiation in their learning[1]. But this new approach is not pure gain with zero risk. Beginning a new class term with project elements undefined and without expert mentors poses certain hazards:

- Students may be slow to define projects
- Teams may not agree on a project
- Teams may lack the skills for a project
- Instructors lack adequate time to coach individuals/teams through the above challenges

In the following methods, we outline strategies to mitigate the struggles and hazards of both the traditional and proposed methods of team formation.

Methods

The pitching and pairing process used in this class is strongly inspired by the methods used at Techstars Startup Weekend events[8]–[10]. Startup Weekend (SW) events gather a diverse group of individuals who are passionate about technology and entrepreneurship. Attendees propose technical problems in which they are interested, but they have not previously planned/developed. Teams are then formed around the most popular ideas, and teams collaborate for 54 hours on a prototype solution.

Given the many parallels between the initial conditions of a SW event and our multi-university course, we chose to adapt their pitching and pairing process for use in our classroom. As shown in Figure 1, students begin the semester with "Solo Study" homework assignments; these include watching online content, published by Techstars, detailing the SW team formation process. Students are also encouraged to participate in a future SW event.

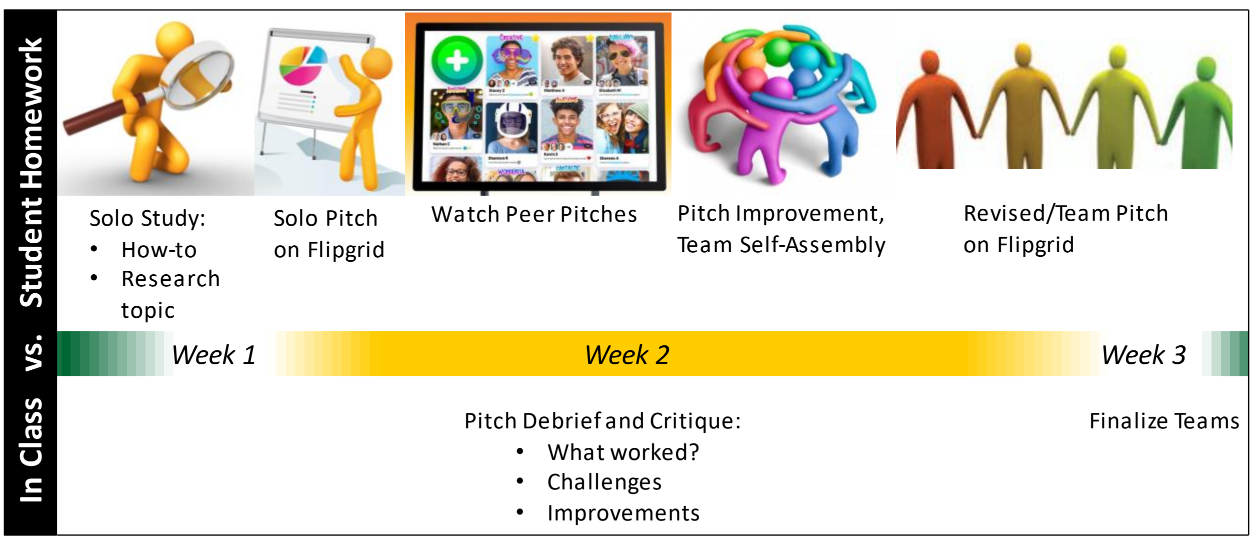

Figure 1. Individual homework tasks and in-class activities are illustrated for the student-led process of project pitching and team formation.

In addition to learning about SW, the first week of in-class time is spent informing students of the non-traditional nature of the course. As homework, they are assigned a Udemy[11] mini-course with topics including:

- Business Concepts: Market Analysis and Idea Pitching
- How to search FOAs[2]
- Project Management: Work Breakdown Structure and Project Plan

- Learning Objectives: Bloom’s Taxonomy, evidence of learning, and external value

After completing the Udemy course, students are instructed to post individual Flipgrid[12] videos pitching their idea, their technical skills, and the skills they are seeking for collaborators. Flipgrid was chosen as the video posting tool for several reasons:

- Password Protection
    - A single password was distributed to all students. Student videos were not publicly accessible but were viewable by all other students. With a single Flipgrid URL and password, students were immediately presented with the opportunity to record their video or view those already submitted by their peers.
- Browser-Based
    - No app to download, install, or learn.
    - All audio/video recording is conducted within the Flipgrid website.
    - The Flipgrid website can be accessed on a variety of platforms including: Windows, macOS, iOS, or Android devices.
- Grid View
    - As suggested by the name, Flipgrid presents content in a grid format which students can quickly “flip” (or scroll) through. See “Watch Peer Pitches” in Figure 1. Presenting a grid of photos and names encourages the class to learn one another’s names and faces; this is valuable both for team formation and subsequent peer-review and critique activities.

The individual pitch videos are due the beginning of week two. Both the Udemy and Flipgrid activities are completed as homework assignments outside of class. In-class time is spent answering student questions and reinforcing the interplay between personal freedom and accountability in the course.

In week two, personal pitch videos have been completed. In-class time is spent discussing struggles and victories encountered while making these videos. Constructive critique is modeled in class; peer assessments of this kind are used heavily throughout the course. Students are encouraged to watch their peers’ videos and identify both strengths and needed improvements. Students are then assigned a second Flipgrid video; the second video is intended to apply the improvement lessons discussed in class. For the second video, students may again pitch individually, but they now have the option of partnering and pitching with other students known to have similar interests. Peer-to-peer communication is facilitated through a classroom Slack channel. Students are advised that teams must have 2-5 members, and they are encouraged to seek a diversity of both subject/discipline expertise and level of education.

In week three, all pitches are complete. At this point, out-of-class administrative effort is required on the part of the instructor. The instructor views the second round of Flipgrid videos and tabulates which students are associated with which teams. In our experience, most students have chosen to self-assemble teams prior to posting their second pitch video. If students remain without a team, or are in an understaffed team, then remaining pairing can be quickly addressed in the first class session of week 3. In-class time for final pairing is minimal as the revised Flipgrid videos clearly delineate the technical objective, existing members, and needed skills which each group has/needs.

Results

Students were asked to rate their satisfaction with both their Teammates and their team's Topic. As seen in Figure 2, the majority of students reported being very satisfied with both their teammates and their research topic. Twenty-two students responded to this question. The mean teammate satisfaction score is 4.3 (out of 5), and the mean topic satisfaction score is 4.2 (out of 5).

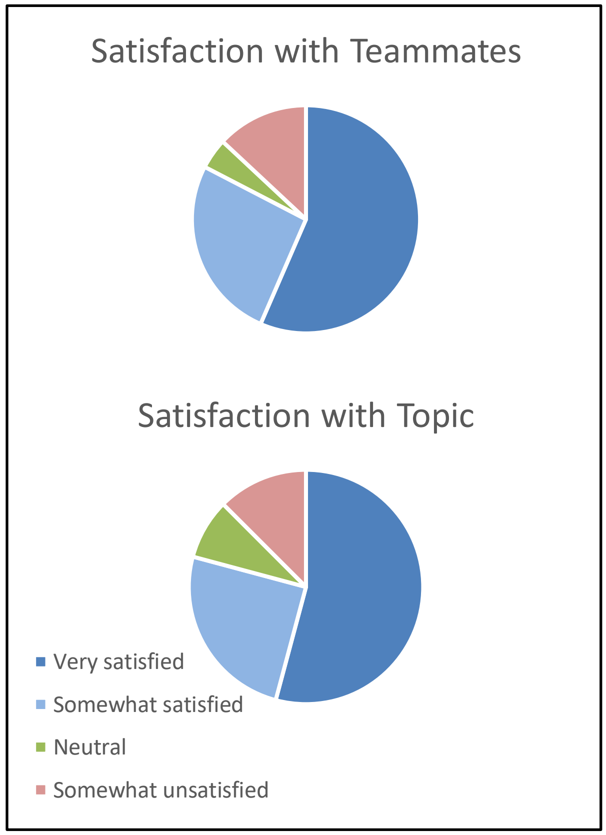

Figure 2: Student Satisfaction with Teammates and Topic. At the end of the semester, students were asked to report their satisfaction with both their Teammates and Research Topic. Options were "Very satisfied" to "Very unsatisfied." No responses of "Very unsatisfied" were received. Numbers are based on all 22 survey responses received from 35 enrolled students.

Students were also asked to describe the process used to form teams; their responses are presented in Figure 3. Students were permitted to choose multiple descriptors from a list, and they could also enter their own word (not found in the list). Again, 22 students responded to this question. Interestingly, six students who chose negative descriptors (Frustrating, Confusing, Time-Consuming, and Chaotic) also chose "Fair"; this shows an overwhelming acceptance of the teaming process's validity and may indicate that the course causes students to experience beneficial eustress rather than negative distress. This aligns well with our overarching teaching philosophy of, "freedom, transparency, and responsibility."

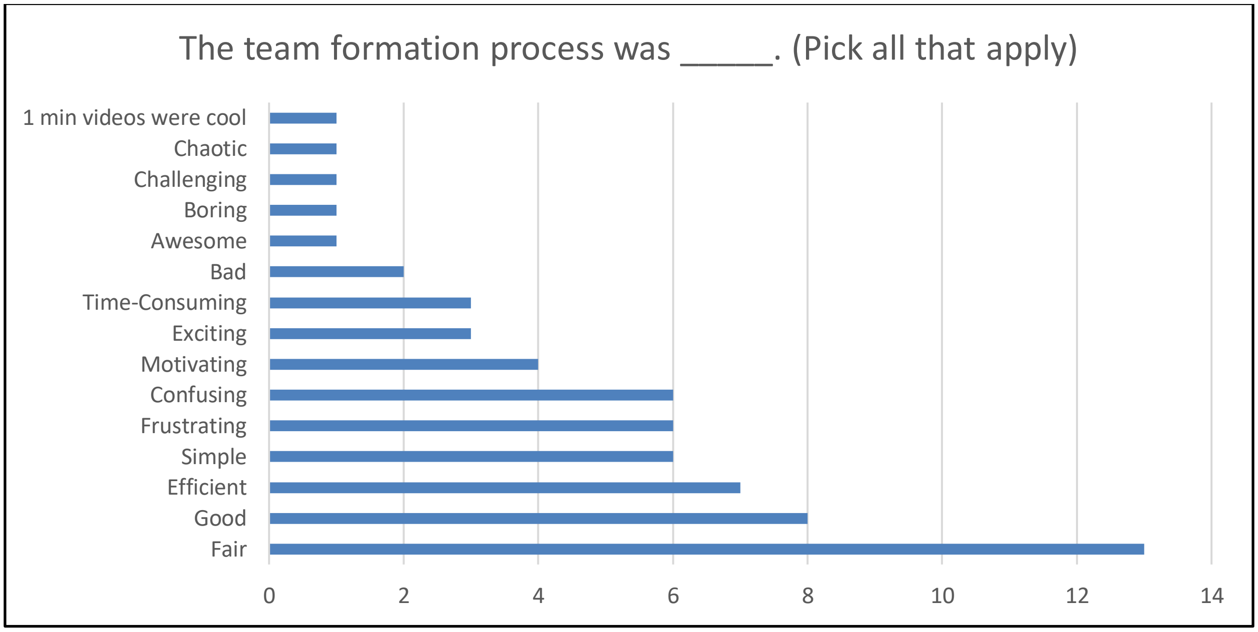

Figure 3: Students were asked to describe the team formation process. Students could choose one or many adjectives from a provided list, and a free text box was provided for typed responses.

In free-form responses, students were divided on whether more-or-less time should be allocated for team formation. Students suggested supplementing Flipgrid videos with searchable text (i.e. keywords) for each individual or team. Students also proposed that homogenous (same degree program) teams should not be permitted.

When asked how they would describe the course to a peer, the top responses (in order) were: Time Consuming, Satisfying, Beneficial, and Frustrating. The descriptors Satisfying and Beneficial are obviously positive. The descriptors Time Consuming and Frustrating may be interpreted in either a positive or negative light, and this is affirmed by analyzing coincident student choices. Several students paired Frustrating with Beneficial and/or Relevant; again, we infer that eustress is present and that students recognize the growth and learning which they experience as a result of being challenged in the course. In short, students view this course as difficult but worthwhile.

Future Improvements

As noted above, the Flipgrid activities could be easily improved by instructing students to enter keywords (their major, their project topic) into the "Description" box provided at the end of Flipgrid's video creation process. This would allow students to quickly find a particular video using text search (ctrl+f) instead of re-watching videos. Homogenous groups could also be either discouraged or disallowed as a part of the grouping instructions. Additionally, a "Version 1.5" of the Flipgrid videos is under consideration; this would provide an opportunity for individuals to improve their videos based upon peer feedback. This change is based on student feedback provided at the end of the semester; adding this revision step could extend the total timeline by approximately 2 days. Finally, to further reduce instructor workload, the task of tabulating which students are on which team will be moved to a shared spreadsheet which all students can edit. Though the instructor may provide a quality check, the majority of data entry can be done by the students as they form their teams.

Conclusion

The pitching and pairing process presented in this paper reduces instructor workload and increases course scalability while teaching students business, entrepreneurship, and self-management skills. Using online tools, the process can be executed quickly, at the beginning of a semester, with minimal in-class time. Students report high satisfaction with the resulting teams and topics. In just one semester, these self-selected and self-directed student groups successfully presented their work at academic conferences, published peer reviewed papers, won awards at conferences and even prepared patent applications. Two groups within this cohort are poised to form a company around their project, as evidenced by their participation in business pitch/incubator events as well as their efforts to protect intellectual property. Students in prior terms have launched a company in this fashion [13], [14]. Finally, as another option for future involvement, students have been exposed to resources from Techstars Startup Weekend. Students in this course are being equipped for future success in academic or industry careers as they learn to brainstorm, plan, and execute a team project.

References

[1] M. Vansteenkiste, W. Lens, and E. L. Deci, “Intrinsic Versus Extrinsic Goal Contents in Self-Determination Theory: Another Look at the Quality of Academic Motivation,” *Educational Psychologist*, vol. 41, no. 1, pp. 19–31, Mar. 2006, doi: 10.1207/s15326985ep4101_4.

[2] E. A. Vazquez, M. Pearson, L. Singelmann, R. Striker, and E. Swartz, “Federal Funding Opportunity Announcements as a Catalyst of Students’ Projects in MOOC Environments,” in *2019 IEEE Learning With MOOCS (LWMOOCS)*, 2019, pp. 79–83, doi: 10.1109/LWMOOCS47620.2019.8939657.

[3] M. Pearson, E. Swartz, E. A. Vazquez, R. Striker, and L. Singelmann, “Driving Change Using MOOCS in a Blended and Online Learning Environment,” in *2019 IEEE Learning With MOOCS (LWMOOCS)*, 2019, pp. 96–100, doi: 10.1109/LWMOOCS47620.2019.8939632.

[4] L. Singelmann, E. Swartz, M. Pearson, R. Striker, and E. A. Vazquez, “Design and Development of a Machine Learning Tool for an Innovation-Based Learning MOOC,” in *2019 IEEE Learning With MOOCS (LWMOOCS)*, 2019, pp. 105–109, doi: 10.1109/LWMOOCS47620.2019.8939621.

[5] R. Striker, M. Pearson, E. Swartz, L. Singelmann, and E. A. Vazquez, “21st Century Syllabus: Aggregating Electronic Resources for Innovation-Based Learning,” in *2019 IEEE*

Learning With MOOCS (LWMOOCS), 2019, pp. 75–78, doi: 10.1109/LWMOOCS47620.2019.8939640.

[6] E. Swartz, M. Pearson, E. A. Vazquez, R. Striker, and L. Singelmann, "Innovation Based Learning on a Massive Scale," in *2019 IEEE Learning With MOOCS (LWMOOCS)*, 2019, pp. 90–95, doi: 10.1109/LWMOOCS47620.2019.8939635.

[7] D. T. Conley and E. M. French, "Student Ownership of Learning as a Key Component of College Readiness," *American Behavioral Scientist*, vol. 58, no. 8, pp. 1018–1034, Jul. 2014, doi: 10.1177/0002764213515232.

[8] M. Murley, "How to Pitch at Startup Weekend," *Techstars*, 29-Mar-2016. [Online]. Available: https://www.techstars.com/content/startup-weekend/pitch-startup-weekend/. [Accessed: 25-Jan-2020].

[9] *How to choose your team for a Startup Weekend?* .

[10] *YEC's Marc Nager Talks About How Teams Are Formed at Startup Weekend*. .

[11] "Online Courses - Anytime, Anywhere," *Udemy*. [Online]. Available: https://www.udemy.com/. [Accessed: 25-Jan-2020].

[12] "Flipgrid," *Flipgrid*. [Online]. Available: https://info.flipgrid.com/. [Accessed: 25-Jan-2020].

[13] "Students earn entrepreneurial grant, featured in online article." [Online]. Available: https://www.ndsu.edu/news/view/detail/25705/. [Accessed: 27-Feb-2020].

[14] A. W. | Jun 28th 2017 - 3pm, "NDSU assistant professor studying spider silk in hopes of applying its properties to biomedical research," *INFORUM*. [Online]. Available: /business/4290252-ndsu-assistant-professor-studying-spider-silk-hopes-applying-its-properties. [Accessed: 27-Feb-2020].