WIP: Incremental innovation training as a means for percolating faculty teaching culture change: A first look

1. Introduction

With funding from a National Science Foundation (NSF) IUSE/PFE: Revolutionizing Engineering and Computer Science Departments (IUSE/PFE: RED) grant, our vision is to focus on faculty development and culture change to reduce the effort and risk experienced by faculty in implementing pedagogical changes and to increase iterative, data-driven changes in teaching. Our project, called Teams for Creating Opportunities for Revolutionizing the Preparation of Students (TCORPS), is an adaptation of the "Additive innovation" model proposed by Arizona State University [1].

The Department of Mechanical Engineering at Texas A&M University has a long legacy of individualistic and---in many cases---a fixed mindset [2] approach to teaching with the expectation of top-down management of change. The goal of our project is to evolve the departmental culture to a bottom-up team structure where the faculty embrace an innovative mindset and extend an iterative build-test-learn method of the maker culture [3] that was formalized by the Lean Startup [4] approach. Faculty already have investigative and experimentation-driven processes in place for research and a keen understanding of data to support their hypotheses. We aim to leverage this preexisting strength and knowledge by extending it to the faculty-led, small-scale, iterative improvement of curriculum and pedagogy.

2. Activities

As a first iteration for the development of this culture and to initiate communities of practice, we invited faculty to form teams to identify a student outcome that they needed to address and to hypothesize what incremental innovation has the potential to address this change. Next, we held a summer workshop series to provide an "innovation mindset training" and a learning/sharing community for the faculty who were selected. Rather than discuss the specific curricular change, a formal process for incremental innovation were taught to our faculty learning community based on the idea of a hypothesized ***build-measure-learn-share-modify*** (B-T-L-S-M) Cycle. These workshop sessions were led by former industry leaders experienced with culture change in a business environment. The faculty also enrolled in an online course on the innovation mindset. Much has been discussed and written about faculty development approaches for Engineering Faculty [9, 10, 11, 12] and several successful strategies, some on very large scales, have been carried out to address specific faculty proposals. We believe that the current approach is one of the first to focus on innovation training as a means for faculty development. In this Work-In Progress paper, we will describe our educational innovation pilot teams, innovation training approach, and preliminary analysis and findings on the evolution of faculty mindset.

3. Initiation of Educational innovation teams

TCORPS was launched in September 2020 (with substantial modifications due to COVID-19), with the first cohort recruited in March 2021 for participation in the Summer 2021 faculty development workshop. To help initiate the culture change, faculty were invited to form teams to propose small changes that they would like to implement into existing course curricula. The teams were asked to submit (a) the title of their innovation, (b) the course(s) involved, (c) the participants in the community of practice, (d) the teaching innovation that was being proposed,

(e) the current practice that they are seeking to change, (f) if their innovation was focused on any historically underrepresented demographic group, and (g) whether they were willing to participate in the summer workshop series. A total of 10 project teams (with approximately 15 faculty out of a total of about 70 faculty) submitted proposals; these 10 teams had considerable overlap across their membership. Finally, four teams were selected as the pioneers of educational reform. They were chosen to ensure that the maximum number of faculty participated while keeping the group to manageable sizes. Their proposals are: (1) Conceptual Rapid Fire Ice Breakers (related to manufacturing); (2) Real World Material Science; (3) Music of the Machines (related to our instrumentation course); (4) Professional Development (related to teaming and, unlike the other teams, would affect multiple courses), and all the faculty are willing to participate in the summer workshop series.

4. Framework to Encourage Innovation:

4.1) Faculty development workshop: The workshop was focused on introducing faculty to the basics of student outcome measurement, student diversity, and student learning; and, on the other hand, on the discussion of innovation, goal setting, and educational (pedagogical and curricular changes) processes. The faculty development workshop series spanned the entire summer. It was composed of six 2-hour workshop classes (Table 1), an online (mostly) self-paced innovation mindset course, and four optional informal working sessions.

Table 1: workshop topics

Sequence	Topic	Session lead's expertise
1	Kick-off	PIs of the grant
2	Pedagogy and assessment sharing toolkits	Engineering education
3	Psychology and teaching, learning, and thinking	Psychology
4	Goal setting (AGGIES process; see below)	Innovation and business practices
5	Innovator mindset	Innovation and business practices
6	Iterative learning	Innovation and business practices

The innovation training aimed to help team members understand and develop an innovation mindset and provided tools to enable the participants to implement an iterative learning framework to improve their student-outcome-oriented teaching goals.

4.2) Build-measure-learn-share-modify model (B-M-L-S-M): The highlight of this model is to help faculty organize themselves into communities of practice [3, 8] that are (1) inspired by shared artifacts/ideas, (2) openly share and learn about the technology and process used to create these artifacts/ideas, (3) design and prototype their own modified version of the shared artifact/idea, and (4) share their modified artifact/idea back with the community [3]. To encourage faculty to innovate at an incremental scale, each teaching experimentation is expected to go through this B-M-L-S-M cycle with an expectation that pedagogical changes will be continuous and based on the notion of a minimum viable product (MVP) [5] [6]. The lean startup approaches [4] [5] were introduced in the workshop. We encouraged faculty to build their MVP through this

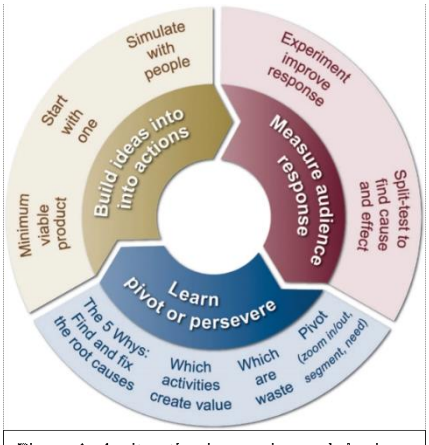

Figure 1: the iterative innovation and sharing culture that we seek to develop in the faculty and students [4].

process: start with a set of assumptions; determine what to learn first by identifying the riskiest, or "leap of faith", assumptions; then determine what to measure to prove or disprove the "leap of faith" assumptions; and finally design an MVP to test their assumptions. The MVP helps faculty start this circle as quickly as possible at minimal costs and resources.

4.3) AGGIES process: We introduced the AGGIES process [4] to every team to help their goal setting, where 'AGG' is the Absolute Greatest Goal, 'I' is indicators, 'E' represents the expectations and accountability, and 'S' is the scoreboard for keeping track of progress. The teams were coached to focus on taking action to improve the leading indicators (to predict and influence the results), rather than the lagging measures (results) themselves. As examples, leading indicators could include student attendance, student engagement in optional practice sessions, and student errors on practice questions (both number and type) whereas lagging indicators could include student grades, student end-of-semester or senior design project content, or students making connections between curricular components across courses. In the workshop, each team brainstormed their student-outcome-oriented AGG in the form of "from X to Y by when"; where X and Y represents the improvement in their lagging measure over time. For example, a good AGG might be "from 50% of students to 75% of students connecting material from Course 1 to Course 2 by the end of one year." Next, the teams determined the leading indicators expected to influence their AGGs. The faculty participants then designed a scoreboard to track both their lagging measures and leading indicators. Finally, the teams scheduled their regular AGG meeting where the teams would meet to (1) report out on preceding AGG meeting commitments, (2) review updates to the scoreboard, and (3) commit to actions aimed at improving the leading indicators, thereby setting the expectations of what each team member should accomplish prior to the next AGG meeting.

5. Assessment on the evolution of faculty mindset

To study the effect of the workshop series in modifying the faculty's mindset and behavioral change, we have carried out work from two aspects. First, before the innovation mindset training, faculty are required to take the online innovator mindset course [13] including an assessment, and after the workshop, the faculty took the innovator assessment again. We compared these two assessment scores. Second, the teaching innovation proposals were rewritten by each team after the workshop to determine if their goals and plans have changed to align with iterative learning practices taught in the workshop. We developed a systematic rubric to evaluate their proposals and assess how well they internalized after the training based on the pre- and post-proposals. The rubric is scored from 1-5 on seven aspects and 4 grant members assessed based on it.

6. Preliminary results and reflections

Qualitatively, based on the innovator assessment reports, it shows that every faculty's overall innovativeness index has increased in the first assessment, and some have greatly improved. The growth in almost all the four assessment areas: Awareness, Creativity, Bravery, and Openness.

We analyzed the twice innovation proposals and scored the assessment based on the rubric. The rubric consists of 5 elaborated scales towards 7 different aspects for comprehensive assessment of faculty's innovation plan. The 7 aspects for assessment and its pre-and post-workshop scores (average of all teams) are listed in table 2. The score of each content is calculated by the average given from the 4 assessment members.

Table 1: Rubric and assessment score

Rubric	Content	Pre-	Post-	Improved
1	Whether their goal was student outcome oriented?	2.33	2.75	+0.42
2	Whether their activity is aligned to their stated goals and leading measures?	2.17	2.5	+0.33
3	Whether they have leading indicators and lag measures for tracking their progress?	1	1.33	+0.33
4	Whether they have articulated any plan for tracking their lead and lag measures and making plans for modifications?	1	1.33	+0.33
5	How do they address inclusivity in their plan?	0.08	1.08	+1
6	Did they articulate the state change like "From X to Y by When"?	0.25	1.25	+1
7	Are they taking an incremented/ iterative approach, or is it a big upheaval?	0.75	1.83	+1.08

A preliminary look at the original (pre-training) and revised (post-training) project description reveals a number of changes in how faculty approach their teaching innovation projects. From the data level, after the workshop, almost all the teams got higher score. They utilized iterative innovation model and improved their proposals. From the details, we also found: First, faculty moved from "perceived problem" centric statements before the workshop to "student outcome oriented" statements after the workshop. Further, teams articulated their goals following the workshop in the form of an AGG (from X to Y by when), even though the content of the proposed activities did not change much. Third, the team's scores improved the most in items 5, 6 and 7 above. In the case of the same activity plan, each team could now formulate goals and plans in stages, and consider continuous updates based on phased learning and feedback.

We also note that following the summer workshop series, it became clear that the teams wanted more opportunity for feedback and support from the workshop leaders (who are also the grant team) and the other teams. Thus, the teaching innovation members meet with the workshop instructors over the academic year on a monthly basis starting from 2021 Fall semester to update their progress, share learning on their MVPs and discuss optimization options for future work. Graduate students and TAs, other faculty, and the department head are also invited to this "RED monthly meeting" to provide their feedback and suggestions, making it a bottom-to-up structured, orderly expanded, continuous learning and sharable community. The department has generously provided lunch for all the attendees.

7. Conclusions and Future work

Based on the dual assessment measures, it is found that faculties consciously follow the innovator mindset methodology to formulate their teaching plans. Every team has a common sense of iterative teaching innovation, which proves the contribution of the incremental innovation training as a means for percolating faculty teaching culture change.

Two activities are underway: we are tracking how well the different teams are applying the iterative innovation methodology taught in the workshop during the implementation process on the "RED monthly meetings"; we also plan to release surveys at the end of each semester to further measure faculty's teaching innovation outcome, also from the perspective of the student learning outcome, and gather their learning reflections. We will summarize this part of the work in our next academic year.

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