Making Value for Faculty: Learning Communities in Engineering Faculty Development

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Communities of practice among educators are often enacted in the form of Faculty Learning Communities, which are groups of faculty who engage over time to collaborate on active learning toward professional development as teachers[1]. Though some debate exists about what should truly be called a Faculty Learning Community[1–3], we can make the following important generalization: Faculty learning communities are typically ensemble-driven. The facilitator acts as a supporter, organizer or co-learner, and all faculty members take roles in providing or analyzing relevant content and steering group inquiry. Given the time to develop, the community itself becomes a key component of faculty growth; the ensemble provides a means for social learning, group problem solving, support, and motivation toward teaching innovations.

This combination of ensemble and time provides remarkable benefits to faculty. Learning communities have been found to promote deep learning[4–6], promote faculty cohesion[5,7], and encourage faculty to strive for improvement and adopt or adapt new practices to their own classrooms[8,9]. Furthermore, learning communities improve faculty's experience as educators by reducing isolation and situating them in ready-made supportive cultures[5,10].

In addition to their value to individual educators, learning communities are well-suited to address broad concerns within the engineering education community. Learning communities have been used to disseminate research-based teaching innovations[2,5]; to provide an impetus for classroom innovation[6,11]; to underscore student-centered learning[10]; to inspire interest, support, and value for teaching[5,12]; and to undergird shared vision and change among faculty[5,10]. For these reasons and more, learning communities should be a more visible and common means to help engineering faculty to learn, share, and thrive.

Building a Faculty Learning Community: A High Bar?

How should a faculty learning community be formed? How should it operate? And who should set the process into motion? The most visible recommended practices for faculty learning communities in higher education come from the highly influential pioneering work of Milt Cox and his colleagues at Miami University. From their literature directed toward learning community builders[10,13–15], we might infer that:

1. A learning community must gain broad support within the hierarchy of an institution, including deans and departments and faculty.
2. A learning community is best situated within a campus center for learning communities, as one of many learning communities under the guidance of dedicated facilitators and a director.
3. A learning community should incentivize membership, whether through stipends or reduced teaching requirements or by implying a selective status for members.
4. A learning community requires high commitment on the part of its members, including frequent meetings, yearly projects, and possible outreach, retreat, or social outings.

5. A learning community meets for a minimum of six months and ideally a year; and it has a finite duration.
6. A learning community has 6-15 members, and ideally 8-12.

The portrait of a learning community that emerges from these recommendations is of a program that is highly integrated, supported, resourced and structured—a well-oiled faculty development institution-within-an-institution. This model shows the clear influence of highly successful efforts in student learning communities and K-12 faculty learning communities, both of which can (and perhaps must) make use of top-down organization, heavy incentivization, and explicit reward structures for participants. This tightly integrated model has proven enormously successful in many of its implementations in higher education, most notably the learning community program at Miami University itself.

Yet the high bar implied by this tightly integrated model poses certain difficulties for learning community newcomers. Communities of faculty are not always instantiated as a fully-realized top-down program; rather, they are often nucleated by a few individuals who see community learning as a way to solve a local problem or provide opportunities to a small network of faculty[16,17]. To these individuals, recommendations that espouse broad support, faculty commitment, and program resourcing may not be of immediate use. Worse, the individuals may falsely conclude that a tightly structured and integrated learning community is the only kind that can provide faculty with the benefits of deep learning, support, and shared vision.

We find in practice that faculty learning communities can thrive and sustain themselves with a variety of models: ones that mimic, adapt, or diverge from the tightly integrated model described above. Within the engineering education community alone there are numerous successful models currently in use. Many require limited commitment, bottom-up organization and no incentivizing beyond faculty's value for the community learning experience. By taking a closer, comparative look at the breadth of faculty learning communities that exist in practice, we may provide a complement to the existing learning community literature that helps to make faculty ensemble learning more accessible to local problem-solvers and large-scale program-builders alike.

In this paper we examine five learning communities that serve engineering educators. These examples represent five different models of how an ensemble of faculty and facilitators can collaborate over time to improve faculty's teaching practice and experience. We look at the strengths of these models as well as the challenges, and offer lessons for the benefit of others who are considering learning communities of their own within engineering education. We analyze themes across the learning communities, and provide recommendations towards building a broader set of best practices for learning communities and communities of practice that reflect the goals, constraints, and resources of engineering education and faculty development.

Naturally, this paper does not constitute a comprehensive review of faculty learning communities within engineering, nor are our five profile communities intended to provide definitive archetypes. Rather, this paper is a starting point for further consideration of the roles that learning communities may take in engineering education and the practices that support these communities. Our hope is that this work will act as a beacon to encourage greater participation in learning communities themselves as well as more active analysis, toward better understanding of

good practices for starting, maintaining, and refining ensemble-driven learning among engineering faculty.

Faculty Learning Communities in Practice: Five Profiles

Here we present profiles of five different learning communities that exist partly or wholly within the community of engineering education. These learning communities represent a breadth of different models for learning communities, implemented to satisfy a breadth of faculty needs under a variety of constraints. Features of these communities are summarized in Table 1.

University of Alaska Fairbanks
Office of Faculty Development Faculty Learning Community Program:
Flipped Class Learning Community

In 2013, the University of Alaska Fairbanks Office of Faculty Development initiated a program of faculty-led Faculty Learning Communities. This program was designed with faculty ownership in mind: facilitators were selected from interested faculty who'd submitted a community proposal around the topic of their respective choosing. The Office of Faculty Development provided training for these selected facilitators, but otherwise left the running of the learning community to the facilitators and faculty. Each faculty learning community was provided with a small budget ($1500), was required to meet about every three weeks throughout the academic year, and was asked to provide a short report at the end of the year.

The Flipped Classroom Faculty Learning Community, in particular, was proposed to explore the pedagogy of an inverted or "flipped" classroom and the technologies available to support flipping. The community was facilitated by an engineering faculty member, and it attracted community members from engineering; it also attracted others from across campus encompassing such diverse disciplines as education, library science, chemistry, biology, and atmospheric science. The group's intended purpose was to lower the activation barrier to help interested faculty try flipping, by sharing group knowledge and experiences. Accordingly, the learning community was planned as a "working" community where members would learn from each other as they redesigned and flipped their respective course(s) and created online material. The specific goals of this learning community were to: 1) Explore pedagogy of a flipped classroom. What do students do within and outside of a flipped class? 2) Explore technologies available to support flipping a course. 3) Flip (redesign) an existing course. Create online material(s). 4) Explore successes/failures of flipping the classroom real-time.

Throughout the fall (2013) the community worked on flipping specific courses that would be taught in spring or the following fall. Topics explored by the community included planning and assessment of flipped classrooms; and training in supportive technology, such as Blackboard and EdX platforms, video capture, pen casting, and Captivate.

During the spring (2014) the community primarily discussed the successes and failures of their newly redesigned flipped courses in real-time. Community members provided each other

support; when one member hit a rocky area within his or her course, others suggested strategies of improvements. The community also started a website (http://flipped.community.uaf.edu/) to share their experiences and gained group knowledge with a larger audience.

The impact of this faculty learning community is best measured through the voice of the participants:

"I think it is great for new faculty because they get to meet other folks across campus and it exposes those that have a more traditional education exposure to some of the cool things that can be incorporated into teaching. I think most folks had some kind of technology tool related epiphany at some point in the year. I usually have better ideas than I can really implement by myself and having a group of tech savvy folks around to help come up with an implementation strategy was really helpful."

"Working in the isolation of one's own classroom frequently leads to frustration and pathways best not traveled down. Sharing and learning from this group of faculty introduced me to new technologies, ideas for in-class activities, and moral support for my efforts. It is always great to have a cheering section at your back and to cheer on others as we all work to improve the learning of our students."

One lesson learned is that framing the community as a working community made for a powerful learning experience for faculty. Having the time to discuss a topic in depth, go try it out, then come back and discuss how it went was incredibly useful. The occasions when the community members applied the same techniques and reported different results provided lots of opportunity for practical grounded learning. A second lesson is that part of the success in the first year was having members with a similar level of expertise for the topic as well as interest; mixing the cohort's level of expertise provides challenges. The flipped classroom learning community was reprised in 2014/2015 with some returning faculty and some new faculty, and the mix has made the cohort less cohesive as the first year.

The learning community provided collaborative relationships that helped learning, and also fostered Scholarship of Teaching research that benefitted the community members. For example, a Ph.D. student in engineering education created a formative survey of the facilitator's first year teaching the flipped model. The results of this study were incredibly instructive for both the facilitator and the community, and were published at the 2014 ASEE conference[18]. Based on work with the Flipped Class Faculty Learning Community, this same student has now surveyed two other flipped classes and will present that work at 2015 ASEE conference[19]

University of Florida
Materials Science and Engineering Junior-Level Faculty Community of Practice

The Department of Materials Science and Engineering at the University of Florida has been undergoing curriculum redesign using research-based learning strategies and data-informed decision-making. One goal of this redesign is to improve the "constructive interference" between related classes—to ensure that courses are designed to make use of opportunities to help students

build and transfer knowledge across their coursework. A particular opportunity for such bridge-building existed within the Junior-year course sequence: though students as a cohort take a proscribed sequence of experimental laboratory courses and concurrent theoretical courses, the related content of these courses had not been explicitly connected for students through course design. For the 2013-14 year, Junior Materials Laboratory 1 and 2 were redesigned, including a better alignment the laboratory with concurrent coursework. As part of the work of this design, a natural community of practice was organized among the instructors of junior-level courses.

According to Wegner[20], communities of practice require domain, community and practice. Within the junior-level course instructor community, the domain was the department; the community was junior level instructors; and the practice was a discussion of alignment, content, practices, and addressing current or potential problems within the courses. This community of practice was informal, and composed of knowledge-sharing practices that included storytelling, conversations, and shared teaching practices[21]. Of the four junior-level instructors, three had regular and ongoing informal conversations, almost weekly. Another faculty instructor who taught a blended graduate course also participated in the community.

Prior to the start of the semester, the community of practice's activities included sharing syllabi, coordinating and arranging course exams and large project dates, and a discussion of potentially difficult concepts for students. The community also engaged in informal discussions of the laboratory experiences for students, and where these experiences would overlap with theoretical course material in the junior classes. During the semester, community members continued to meet informally to discuss exams, student progress with course materials, and ways courses and instructors could reinforce concepts in each other's classes. Community members also discussed the level of complexity of the material being presented in the represented courses, so that content delivered to students was at the same level of complexity across the courses.

As an example of the results of cross-class coordination, while the student cohort was learning about phase diagrams in Introduction to Inorganic Materials and Materials and Thermodynamics, they were also measuring cooling curves and creating binary phase diagrams for alloys in the Materials Laboratory. At the time of these student activities, the community members who were junior-year class instructors had discussions about content, practices, and disciplinary literacy for their classes, in order to create a unified curriculum model for students. Through these discussions, a common vocabulary was developed among community members, and the level of complexity was adjusted so that all three courses were delivering and supporting content in the same way for students.

As a result of these community coordination and knowledge-sharing practices, student ratings for the laboratory course included statements such as "*Very helpful course because we are able to use, see and better understand things that we are learning in lecture courses.*" The community members responsible for theoretical courses reported similar statements on their student ratings.

While only in the emerging stages, and as of yet still very informal in nature, the Junior-level Faculty Community of Practice shows the value of faculty conversations centered on student learning. For Fall 2015, instructors hope to further formalize the community-of-practice process,

including an initial instructor meeting and monthly meetings and discussions around content, and student learning.

University of Illinois at Urbana-Champaign
College of Engineering Collins Scholar Program

The Collins Scholar program at the University of Illinois at Urbana-Champaign is a learning community for first-year faculty and instructional staff in all departments in the College of Engineering. It is voluntary and cohort-based; participants meet weekly together for an academic year.

The primary purpose of this learning community is for new faculty and instructional staff to get their careers off to an efficient and productive start. It is intended to provide a culture of support for (primarily) teaching, and (secondarily) research and service, in a relaxing and collegial environment. Specific goals of the community are to help faculty 1) plan, implement and manage effective in-class and out-of-class instruction, 2) develop and use instructional materials, 3) apply research-based techniques of effective instruction, 4) plan and implement evaluations of instruction, 5) mentor students and be mentored by senior faculty colleagues, and 6) make effective use of departmental, college, and campus instructional resources.

Staff members from the college's Academy for Excellence in Engineering Education (AE3) coordinate the program, including topic planning (with input from the participants) and facilitating or identifying speakers for the community sessions. Each week a different topic of interest is addressed. Typical topics have included instructional objectives, active learning, academic integrity, creativity, testing and grading. There is time during each meeting for participants to informally share experiences, successes, and challenges with each other. Outside of the weekly meetings, participants are observed in their classroom once a semester by AE3 staff and trained senior faculty members. Members also observe others, going in groups on "excellent teacher visits" to the classrooms of instructors who are well known for their teaching excellence. As a condition of the community, members are asked to collect mid-term and end-of-term student evaluations.

In 2012, a dedicated AE3 staff member was added to revitalize and coordinate the learning community. Key features of the new Collins Scholars program include: individual visits from AE3 staff to new faculty members to welcome them to campus and personally invite them to attend the program; regular communication from the coordinator via email and Piazza; a professional-looking syllabus; and an end-of-semester AE3 Celebration of Teaching, in which participants receive a certificate of completion from the Dean. Participants also receive a book of their choice on teaching. This revitalization effort also included re-naming the program "Collins Scholars" to add a sense of prestige and meaning to the program; W. Layton Collins is an Illinois alumnus who served as executive director of ASEE for many years.

This constellation of revisions appears to have resulted in significant faculty-buy-in and engagement in this learning community; there was a substantial participation rate for the 2014-15 cohort (83% of new hires). Surveys of participants indicate high levels of satisfaction with the

program. Results point to specific aspects of the program that have been particularly important to the participants: the peer observations, the lunches provided, and a planned social activity (family-friendly pizza party) after work hours. A particularly frequent refrain in surveys is the value of the assembled community itself. The following comment represents a common theme in the surveys: "*I particularly appreciate the productive camaraderie, i.e. being guided to think about and implement important concepts in a peer-supported environment*."

At a deeper level, the program's leadership has discovered that building trust with participants is essential to the success of the program. Especially because this learning community is now coordinated by college administration rather than by faculty, it is critical to ensure that faculty perceive it as valuable and trustworthy. This effort has entailed endeavoring to ensure high-quality presentations at our sessions, to listen and respond authentically to participants' concerns, and to plan and organize the sessions and observations well enough to avoid disruptive and confusing mishaps. The Collins Scholars program has also begun engaging participants from former cohorts in order to increase credibility and the sense of a faculty community. Former participants connect with incoming faculty in their departments to encourage them to join the program; they also attend the annual kick-off event to welcome the new cohort.

Building and maintaining trust is an ongoing challenge in any program or organization, so the Collins Scholars Program's work in that regard is continuous. Another more specific challenge is the mix of tenure-track and instructional staff (non-tenure-track) participants in this learning community. While in some ways this is a healthy combination, these groups also differ in goals, perspectives, and concerns, and it is therefore sometimes difficult to orient the weekly sessions in ways that benefit both groups. A future aspiration of the Collins Scholars program leadership is to find a space for the community that befits its growth and its goals: a regular faculty learning space (ideally a "teaching commons") with a layout that supports interaction and collaboration among faculty.

University of Michigan
Center for Research on Learning and Teaching in Engineering's "Teaching Circle for Large Engineering Courses"

The University of Michigan "Teaching Circle for Large Engineering Courses" is a term-long faculty development program with three main goals: 1) to positively influence faculty's teaching attitudes and classroom practices by introducing compelling research on effective teaching, 2) to provide a safe and supportive environment for participants to implement new teaching practices, and 3) to build a strong community amongst participants. The Center for Research on Learning and Teaching in Engineering (CRLT-Engin, an engineering branch of the campus-wide CRLT) piloted the program to a small group of Chemical Engineering faculty in Fall 2011 and has subsequently offered the program six times for engineering faculty. Prospective members of the Teaching Circle apply to participate, and seven or eight members are accepted per term. (Enrollment is capped because meeting dates are set such that participants can attend all sessions. Such scheduling is only possible with a limited number of participants). At the conclusion of the program, participants are eligible for a $1,000 educational grant to support their large-course teaching.

The Teaching Circle is co-facilitated by a senior engineering faculty member paired with a CRLT-Engin instructional consultant. The program features four monthly sessions, each two hours in length. The facilitators focus on disseminating practical strategies (within reach of the participants) to address common teaching challenges and encouraging participants to share personal experiences—both positive and negative. Sessions feature ongoing support from colleagues and faculty developers, allowing participants to practice in a safe environment.

The Teaching Circle also scaffolds community member engagement with educational research from credible research journals, and supplements this with local data collected from University of Michigan students and faculty. In preparation for sessions, summaries of national research are assigned as pre-reading. These readings are supplemented by local data.

As condition of the program, community members are expected to participate in a midterm student feedback (MSF) session in their class. The MSF is a service provided by CRLT-Engin whereby a consultant observes a class session during the middle of the term and then collects confidential student feedback for the instructor about his/her teaching[22]. The consultant then reports findings to the respective instructor, and together they discuss strategies for change. Teaching Circle members also are invited to observe, themselves. They may participate in the *Classes and Coffee* program, which facilitates group observations of other faculty who are known to make good use of evidence-based teaching practices; observer groups then meet to discuss the class session over coffee.

To date, 41 engineering faculty have participated (or are participating) in the program, and the applicant pool exceeded capacity for all six offerings. The program has been successful in influencing participants' teaching. Faculty self-reports indicate that their enthusiasm, clarity, and interaction increased in statistically significant ways, and objective observations by trained consultants indicate that participants' teaching behaviors changed to increase student engagement and active learning over the term[23,24]. Additionally, participant feedback has been positive, as noted by these two sample comments:

"The possibility of changing my classroom from one of passive learning to one of active learning is the big take away point. I now believe that I can undertake such a transition in an incremental fashion that allows me to avoid huge risky time investments and to take corrective action in a timely manner."

"The program got me to read helpful sources, which in turn got me thinking about my teaching, and gave me some good ideas about both some short-term easy improvements and some longer-term goals."

University of Washington
CELT/EWCD Engineering Writing Brown Bag Learning Community

In 2012/2013, the University of Washington College of Engineering embraced in-discipline writing as a means to better integrate students' communication education with their engineering experience. Faculty who took up this banner often agreed to do so despite limited experience

with writing pedagogy. They were also often isolated within their own departments. The Center for Engineering Learning & Teaching and its Engineering Writing & Communication Development Program designed the Engineering Writing Brown Bag learning community in 2014 to provide an opportunity for faculty to gain background knowledge and a support network.

The Engineering Writing Brown Bag was introduced as a lunch meeting in order to promote a relaxed social learning experience. It is open to all, and attendance is not mandatory. The topics are determined by group interest near the start of the quarter, with some flexibility for interesting ideas that come up over time.

Meetings are one hour. An effective use of this brief time was for the facilitator to come equipped with two discussion questions. The first question provides a prompt for members to reflect upon and share their knowledge and experiences with the group. The ensuing discussion usually engages the group for most of the hour. The second question prompts the members to think of ways to apply new group knowledge.

A predictable drawback of using a low-commitment model among a small faculty community is low attendance. Community meetings are frequently eclipsed by departmental meetings, student interactions, and imminent deadlines. Yet, perhaps surprisingly, low attendance has not affected the engagement and quality of the discussions, nor has it led to attrition of the community over time. A given meeting might bring together any random three of the seven members for an animated discussion; and those who are not present follow along through a weekly email summary. Given its low priority and negligible incentives, faculty's participation in the Engineering Writing Brown Bag suggests that the community provides enough value to compete for faculty's limited attention.

This continuous group membership suggests that learning communities, even very casual and open-ended ones, have much to offer to faculty who are attempting to grow into a new pedagogical mode. Even the self-identified novices in the community made rapid gains in expertise, and all members adopted research-based teaching practices. The group developed and shared a substantial amount of new emergent knowledge together about teaching engineering writing, especially where no appropriate resources existed. And socially, the group reinforced each other's curiosity, vision, enthusiasm and interest for teaching writing within engineering.

Some lessons learned through the first year of facilitating are that community members responded with great interest to others' narratives about learning and teaching. Hearing others' stories freed members to think of solutions more creatively than they could be about their own teaching challenges. Similarly, faculty enjoyed engaging with literature and considered it very seriously. Yet literature itself did not typically cause teaching changes. Community members were more likely to change their mind on long-held practices or consider teaching changes that they perceived as risky after they'd discussed these changes with other members. Despite the importance of conversation toward meaningful change, written expressions provided significant value to the community. Seeing the week's discussion reflected back in text (in the form of a weekly email summary with references) was highly valued by community members, and allowed absent members to retain ties to the community.

	Cohort/ Topic Basis	Duration/ Frequency	Facilitator	Cohort Size	Member projects/ commitments	Incentives
University of Alaska Fairbanks Office of Faculty Development Learning Communities	**Topic**: Proposed by facilitators (e.g., flipped classes)	Academic year; participants meet once every three weeks minimum.	Facilitated by faculty	8-10 per community per year	Participants design and teach a flipped class, and contribute to group website	Acknowledge part of faculty workload, $1000 for group
University of Florida Materials Science Junior Year Course Community of Practice	**Topic:** Junior year materials science courses.	Continuous; participants meet weekly.	Facilitated by faculty	4	Participants work together to align theoretical and laboratory coursework	No extrinsic incentives
University of Illinois Urbana-Champaign Collins Scholar Learning Community	**Cohort:** First-year faculty and instructional staff	Academic year; participants meet weekly.	Instructional consultants or guest faculty presenters	25 – 30 per year	Participants must be observed, collect mid-semester and end-of-semester feedback	Certificate of completion from dean
University of Michigan CRLT-Engin Teaching Circle for Large Engineering Courses	**Topic:** Teaching in large-enrollment undergraduate courses	Term-based; Participants meet four times per term.	Co-facilitated by faculty and instructional consultant	7-8 per term	Participants are expected to do pre-reading, get mid-quarter feedback, observe another large class and discuss with the instructor	$1000 grant to support teaching
University of Washington CELT/EWCD Engineering Writing Brown Bag	**Topic**: Teaching in-discipline engineering communication.	Continuous; participants meet weekly.	Instructional Consultant	7 (average 3 at each meeting)	No commitment or project	No extrinsic incentives

Table 1: Summary of the five profiled learning communities and communities of practice.

Emergent themes across learning communities

Through a simple thematic analysis followed by a group conversation among facilitators, we identified a number of themes across our learning community dialogues. We prioritized these themes along the following four criteria: 1) the theme "resonates": it seems important and/or true about the learning community, 2) the theme adds something novel and useful to the dialogue about learning communities, 3) the theme provides a means to bridge to other concerns/research areas in engineering education, and 4) the theme provides guidance or useful information to others wishing to start or refine communities of practice. Here we summarize the five most relevant themes.

1. The learning communities supported translating education research into practice.

One of our most enduring concerns in the engineering education community is ensuring a bridge between education research and the practice of teaching[25–27]. Learning communities have often been put forward as a good translational vehicle. We certainly see evidence of this across the five programs profiled: three of five programs proscribed reading and application of pertinent research as an explicit goal, and all programs exhibited it as an outcome.

It is worth examining the mechanisms within our learning communities that supported this translation of research into teaching practice. First, it has been observed before that learning communities are "organizing circumstances" for adult learning—that is, to a person generally oriented toward learning (such as most faculty members), learning communities provide a convenient and inviting opportunity to gain new and interesting knowledge[28]. Thus our learning communities provided a means to make research more visible and available to positively disposed faculty.

But our communities' broad successes in fostering research-into-practice translation can hardly be chalked up to research exposure alone. The communities also provided two critical supports that faculty often go without: appropriate time to engage with research, and social incentives to both consider and follow through on making research-based changes in teaching. In our most casual learning communities, members remarked that they liked having a recurring time to set aside other responsibilities and reflect upon their teaching; in our most structured communities, this time was explicitly protected by contract with administration. And the social learning experience prompted active engagement and follow-through. In group discussions about research, it was natural for faculty to conversationally "try on" research recommendations, thus actively adapting the content of readings. And in groups with shared project goals such as University of Alaska Fairbanks Flipped Class Learning Community and University of Florida's Junior-Level Faculty Community of Practice, the social support served to bolster faculty's commitment to see these research-based changes into practice and mutually support their success.

2. The learning communities mitigated risk for faculty.

Across all of our programs, there were signs that learning community participation reduced the risks that faculty associate with instructional change. Peer discussion and feedback helped early adopters of change to feel more secure; as one member of the University of Washington

Engineering Writing Brown Bag remarked, "It was helpful just hearing some confirmation that my ideas for teaching weren't crazy". And the exchange of teaching narratives and resources among the community helped all community members to see instructional change as worthwhile, and within faculty's reach.

Learning communities also reduced faculty feelings of risk and vulnerability associated with assessment. For example: University of Illinois at Urbana-Champaign's Collins Scholars Program, University of Michigan's Teaching Circle, and University of Florida's Junior-Level Faculty Community of Practice each encouraged or required teaching observations of their members. Observations are often fraught experiences for faculty. But embarking upon these observations within the framework of a group helped faculty to cast these assessments more clearly as learning experiences that they'd share, rather than individual trials.

In general, the observed risk mitigation rests upon the success of a learning community as a "safe space" for faculty. Within our profiled communities there was often sharing and assessment, but little evaluation; members were free to explore teaching ideas and practices in an environment that was somewhat shielded from their concerns about tenure and promotion. Yet it is easy to imagine a learning community that does not provide this safety, just as it is easy to picture a class that does not create a psychologically safe environment for students to experiment and learn out loud and grow. Creating a safe space is an explicit goal of the University of Michigan Teaching Circle; perhaps it should be a more explicit goal of learning communities in general, to promote constructive faculty risk mitigation toward instructional assessment and change.

3. The learning communities fostered constructive group problem solving among faculty.

An obvious benefit of gathering a community in support of teaching practice is that it implies a group approach to solving shared problems. A clear example of this can be seen through University of Florida Junior-Level Faculty Community of Practice, which quite explicitly focused on a shared goal of creating a cohesive learning experience across classes. Faculty often met to discuss issues in individual classes, and find group means to coordinate solutions. Thus both the responsibility and the solution for student learning became a group concern.

Even within learning communities in which members had parallel goals rather than shared goals, we saw evidence of group problem solving. For example, University of Alaska Fairbanks Flipped Class Learning Community members rallied to support each other and troubleshoot each other's flipped classes. And within University of Washington's Engineering Writing Brown Bag, social problem solving often came about organically: when one member expressed a challenge, other members jumped in to suggest possible solutions. Faculty often exhibited great creativity when brainstorming others' concerns, which was likely because they were free of the pressure of ownership. Engaging creatively with each other's challenges provided members with a pathway to think more creatively about instructional challenges, in general.

4. The learning communities provided a gateway to other faculty enrichment experiences.

In our profiles and discussion, we often saw learning communities situated within a greater network of faculty development and enrichment activities. In many cases, the learning

community itself served to directly introduce faculty to these other enrichment opportunities, thus serving as a gateway activity toward a more active involvement with teaching scholarship and reflection.

For example, the University of Michigan Teaching Circle and the University of Illinois at Urbana-Champaign Collins Scholars Program facilitated class observations and provided encouragement and scaffolding for faculty members to continue observations on their own. They also both seeded mentorships, thus providing long-term enrichment for faculty. The University of Alaska Fairbanks Flipped Class Learning Community and University of Washington Engineering Writing Brown Bag both provided a foundation for members and affiliates to collaborate on Scholarship of Teaching and Learning projects, which by definition include self-directed reflection on teaching practice. Both the University of Illinois at Urbana-Champaign Collins Scholars and University of Washington Engineering Writing Brown Bag sought to help members to make good use of campus resources and opportunities, thus underscoring the wealth of support that faculty may access toward teaching goals.

It is conceivable that this "gateway" effect of learning communities toward other faculty enrichment isn't specific to learning communities at all. In general, an educator who has had any positive faculty development experience will likely be open to participating in more faculty development experiences. This certainly doesn't diminish learning communities' potential as a transformative professional development activity. Many members in our learning communities were first-time faculty development participants, and went on to utilize or synthesize a breadth of opportunities to pursue teaching excellence. If learning communities bring any of our faculty toward sustained engagement with activities that help them to make their teaching practices rewarding and successful, then this is a good argument for making learning communities a more ubiquitous component of faculty service offerings.

5. The presence of a community of peers helped to build trust in learning communities.

The University of Illinois at Urbana-Champaign Collins Scholar Program's profile underscores the importance of trust toward establishing and maintaining a successful learning community. In order for faculty to set aside time and take the intellectual risks that enable learning and growth within learning communities, faculty members must trust the group, the facilitators, and the process. A notable aspect of the Collins Scholars Program's design to build this trust is that faculty endorsement is implied within prospective members' invitation: the previous Collins Scholars act as the program's ambassadors to new faculty.

The role of faculty members in establishing group ethos is underscored in stories from each profiled learning community. For example, the University of Washington Engineering Writing Brown Bag found that the offer, "Want to meet other engineering faculty who teach writing?" was often met with more interest than "Want to learn more about teaching engineering writing?" Similarly, the University of Alaska Fairbanks Faculty Learning Community Program's faculty-facilitated model was initiated because its developers thought that faculty leaders would garner trust and interest thanks to existing relationships and trust between faculty; this model was indeed very successful in attracting members. Within learning communities, faculty colleagues' ethos played a pivotal role in establishing the consistent trust required to consider and enact

changes. As previously discussed, faculty-to-faculty discussion spurred innovation; and a culture of shared experiences and goals helped each individual to manage difficult or uncomfortable aspects of growth as educators. The buy-in of the faculty collective, and the social standard of openness and neutrality set by the group, helped faculty to overcome resistance and participate openly and constructively.

The particular role of faculty in establishing trust and change across our models is important—it tells us that it is indeed the presence of other faculty, not simply the instance of organizing circumstance, that provide learning communities with much of their appeal and their power to scaffold pedagogical change among faculty.

Conclusion and Recommendations

In this paper we have visited five different instances of learning communities facilitated for or by engineering faculty, representing five different designs for ensemble learning. Despite their differences in structure and scope, we discovered a number of themes connecting our disparate models. By examining these themes, we have illuminated some of the aspects of how and why learning communities provide their breadth of benefits to faculty. Thus our comparative approach to understanding learning communities mimics the epistemology of learning communities themselves: through sharing and analyzing narratives of our experiences, we begin to construct knowledge.

A review such as ours can only scratch the surface of the internal workings of a successful learning community, and can only hint at the practices that make a learning community work and work well for faculty. During our discussions, we often touched on interpersonal topics surrounding learning communities that seemed highly relevant towards establishing better guidance for learning community builders. Among them was faculty self-selection: what kinds of faculty choose learning communities? Does the success of a learning community depend on this self-selection? Regarding those who participate in learning communities, what interpersonal practices of facilitators and members help to build a strong ensemble of learners? What practices help to sustain peer relationships, even beyond the boundaries of the facilitated community? In particular, the community-building aspect of learning community deserves further thought, study, and public exploration, for the benefit of nascent and established learning community programs alike.

Learning communities offer immense value as a component of faculty's lifelong learning and professional development, value that has bearing on our educational community's goal of fostering lifelong learning in students as well. Expanding the pedagogy of learning communities within engineering provides a tool for their increased adoption and success. We hope that what we have presented provides some narrative guidance for those who are considering enacting a learning community among engineering faculty. We also hope that we have provided a starting point toward a closer look at ensemble learning among engineering faculty: its strengths, its design, and its practice.

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