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COORDINATING COLLEGE-WIDE INSTRUCTIONAL CHANGE THROUGH FACULTY COMMUNITIES

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ABSTRACT

In February 2012, the College of Engineering created the Strategic Instructional Initiatives Program (SIIP) to transform and revitalize the core engineering courses at the University of Illinois at Urbana-Champaign. As SIIP has evolved, we have learned that in order to achieve these goals, we must first focus on creating collaborative teaching cultures. This effort has sparked the rapid spread of Research-Based Instructional Strategies across the college and created a thriving community of faculty invested in improving undergraduate instruction. In this paper, we describe the current policies and procedures that we use to direct SIIP. In particular, we will focus on the structure of the leadership team and how we have fostered deep collaborations among faculty developers, education researchers, and engineering faculty. We conclude by presenting an evaluation of the program.

1 INTRODUCTION

In February 2012, the College of Engineering created the Strategic Instructional Initiatives Program (SIIP) to transform and revitalize the core engineering courses at the University of Illinois at Urbana-Champaign. Prior to SIIP, faculty and student satisfaction with the large, introductory engineering courses was waning, and the use of Research-Based Instructional Strategies (RBIS) had remained confined to primarily one department. As is common at research-intensive institutions, the research-focused culture stifled conversations about innovative teaching, isolating innovators who thought their work would not be valued at large [1]. During its three years of existence, SIIP has sparked the rapid spread of RBIS across the college and has created a thriving community of faculty invested in improving undergraduate instruction. For example, the context-rich collaborative problem solving RBIS [2] (students working in teams to solve difficult, real-world engineering problems) has now been integrated into 14 SIIP-affiliated courses in five departments and is now being practiced by 27 faculty instructors, most of whom had not been using this RBIS before SIIP [3]. Similarly, classroom response systems (i.e., clickers) and peer instruction [4] are being used in 16 SIIP-affiliated courses, most of which had not been using clickers before SIIP. Beyond the rapid adoption of existing best practices, faculty have begun to develop new RBIS such as sketch-based intelligent tutors and adaptive learning plat-

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forms.

Constructed under the guiding principle that education innovations will be sustainable only if they are owned and championed by the faculty, SIIP was structured as a competitive grant program through which faculty applied to conduct large scale renovations of a course or a set of related courses. We (the SIIP administrative team) required that proposals be led by teams of at least three principle investigators, two of which needed to be tenure-track faculty members. Proposals were initially evaluated on their potential to improve student engagement, learning outcomes, and faculty teaching experiences. If awarded funding, proposal teams were required to attend monthly SIIP-wide meetings that would focus on sharing and celebrating successes as well as providing brief workshops to better equip faculty to make their proposed curriculum changes. After the first year of administering SIIP, we discovered that the formation of faculty communities was the most important outcome of SIIP. Those teams that formed deep collaborations and community most readily integrated RBIS into their courses and demonstrated the possibility of sustaining that integration for the long term. Additionally, the SIIP-wide monthly meetings enabled thought leaders and champions to emerge who led the translation of best practices from one SIIP project to another.

We also became keenly aware that although our faculty are enthusiastic about improving their courses and are experts in their content, they lack training in how to demonstrate or evaluate whether their reforms and innovations are successful. These evaluations sparked the creation of a new model for SIIP and a new central message for communicating its central mission. Our faculty are now rallied around the simple message of "teach like we do research." This message is enacted through a three-stage model of transformation illustrated in Figure 1. First, faculty are organized into Communities of Practice (CoPs) through which they will innovate their courses. Second, faculty commit to an implement-evaluate development cycle for which the CoP must commit to collecting data about their innovations and using the data to inform iterative development. Finally, we expect that the adoption of RBIS will naturally emerge without any mandates from the leadership team or administration.

For the remainder of this paper we provide theoretical justifications for our three-stage model of transformation, provide details about this model has informed our new policies for administering SIIP, and finally we provide some evaluation metrics to demonstrate the success and impact of SIIP in improving undergraduate instruction.

2 ORGANIZATIONAL CHANGE THEORY

Educational change efforts can be categorized along two axes (See Figure 2): the intended outcome of the change effort (prescribed vs. emergent) and the aspect of the system to be changed (individuals vs. environments and structures) [5, 6].
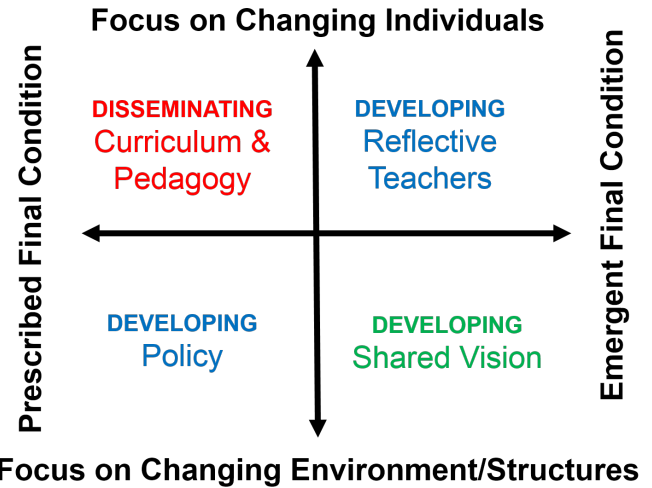

FIGURE 2. EFFORTS TO CHANGE EDUCATIONAL PRACTICE VARY ALONG TWO AXES. EMERGENT CHANGE EFFORTS THAT CHANGE ENVIRONMENTS (I.E., EFFORTS THAT DEVELOP SHARED VISION) ARE DIFFICULT TO EXECUTE BUT CAN BE PROFOUNDLY SUCCESSFUL. ADAPTED FROM [6]

Change efforts in engineering education have historically focused on changing either individuals through dissemination, faculty development (i.e., developing reflective teachers), or by developing policies such as through accreditation standards [7]. There have been few efforts to change engineering education that are both emergent and focused on the environments and structures in which faculty practice engineering education [7]. Yet these long-term approaches that address faculty's belief systems, motivation, and institutional culture have generally been more successful than other types of change strategies [5–9].

Learning theories such as transformational learning theory [10] and other situative frameworks such as Communities of Practice (CoPs) [11] provide insights into why emergent, environmentally-focused change strategies can be effective. Decision-making during instruction and curriculum development are driven by faculty's implicit epistemologies, beliefs, and commitments [1]. When these implicit value systems do not align with the implicit value systems of RBIS, faculty resist the initial adoption of those RBIS or will fail to persist in their use [12]. Transformational learning theory posits that implicit value systems can be changed only through mutual reflective engagement about communal practices such as teaching practices or curriculum design practices [10]. CoPs provide a place for this mutual reflective engagement, inviting faculty to engage in continuously deeper levels with RBIS, from the periphery to the core [11].

At research-intensive universities, faculty primarily engage in research CoPs. The primary mark of membership within these CoPs is recognized depth of understanding in a field of study, as
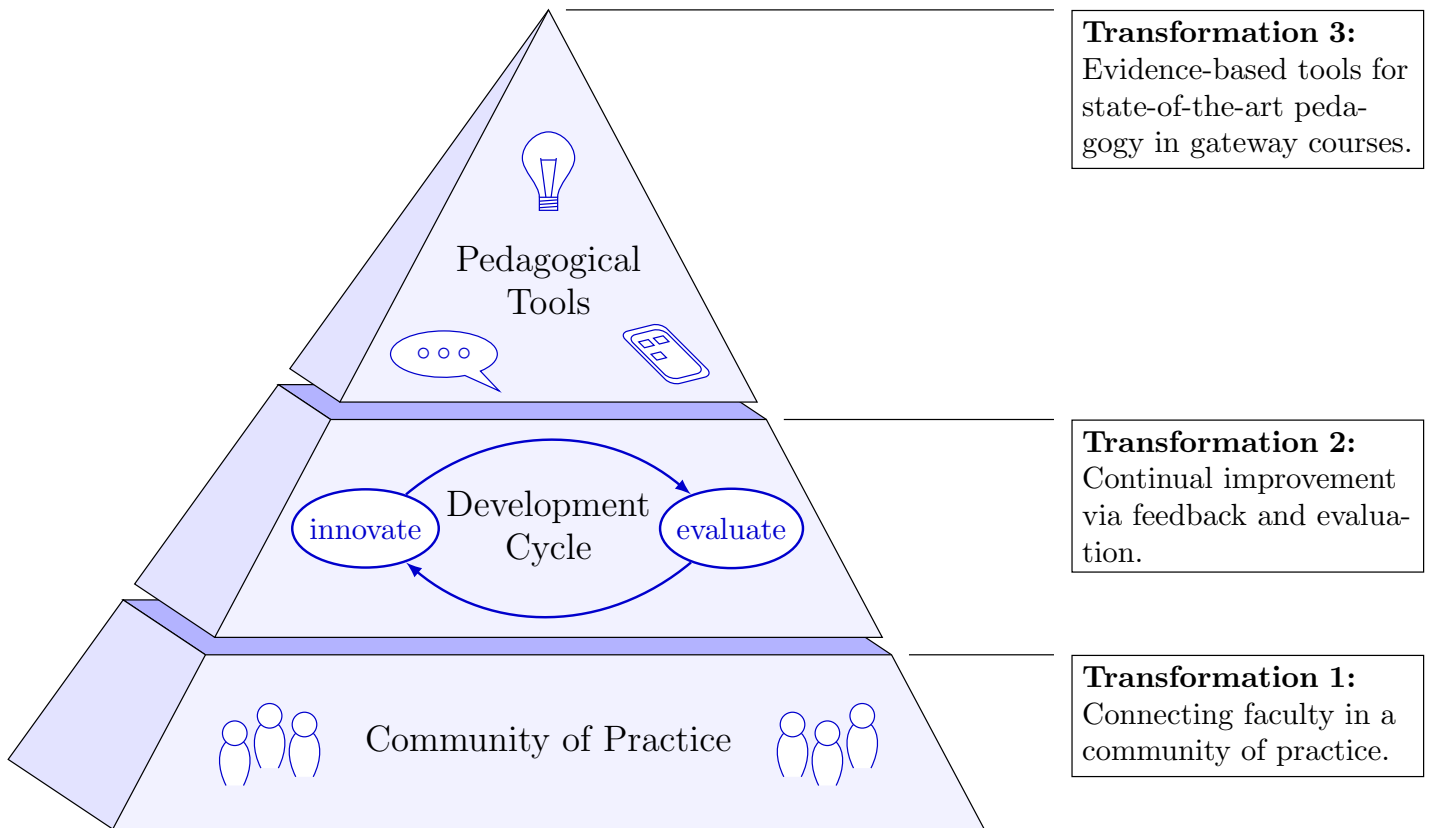
FIGURE 1. THREE KEY LEVELS OF SUSTAINABLE EDUCATION TRANSFORMATION USED TO GUIDE SIIP; EACH LAYER SUPPORTS THE TRANSFORMATIONS ABOVE.

demonstrated by key cultural artifacts such as dissertations and research articles [1]. These communal practices create a central identity of faculty as researchers and as experts [1]. In contrast, the practices promoted by most RBIS do not value faculty as researchers or as experts, promoting student-centric practices that build on students' prior knowledge and experience [1]. The mismatch in values can create a psychological "immune response" that seeks to guard existing identities and value systems and ward off invading identities [13].

CoPs provide a safe environment for challenging this immune system, surrounding resistant faculty with respected colleagues, thus mitigating the perception of identity threat [11]. Within CoPs, faculty engage in long-term situated learning, participating in community-valued practices [11].

To create and sustain functional communities, community leaders must be committed to creating a sense of fair process [14]. Even if faculty achieve desired outcomes such as better prepared students or improved retention, they will resist full participation in change-oriented communities if they do not experience fair processes, complete information sharing, or sufficient provision of resources [15]. When these senses of fair process

are violated, faculty will refuse to engage in even the most basic organizational duties such as sharing teaching materials or collecting evaluation data [16]. When these senses of fair process are supported, faculty will go above and beyond expectations, supporting change efforts even if they are not fully convinced that the best pathway to change has been chosen [16].

3 CURRENT POLICIES OF THE STRATEGIC INSTRUCTIONAL INITIATIVES PROGRAM

Drawing from the organizational change literature, we have updated SIIP policies to better reflect the research literature and to primarily focus on improving the formation of faculty communities and to support faculty in their implement-evaluate development cycles. SIIP is centrally structured around four main features: 1) an academically diverse leadership team, 2) integration of the leadership team into weekly faculty CoP meetings, 3) community-centric evaluation criteria for new and continuing proposals, and 4) a pre-proposal phase preceding the submission of new proposals.

3

3.1 Leadership Team

We have developed a new leadership team constructed of faculty developers, education researchers, and critically tenured engineering faculty members. This academically diverse leadership team is reflected even in the authorship of this paper: Dr. Herman is an engineering education researcher who studies assessment of student learning, Dr. Hahn leads the college's faculty development program, the Academy for Excellence in Engineering Education (AE3), and Dr. West is a tenured faculty member in the Department of Mechanical Science and Engineering whose research focuses on computational methods.

Members from each of these groups meet on a weekly basis to debrief on how each of the SIIP CoPs are performing, to identify common challenges and successes, and to explore avenues for expanding the impact of SIIP. Primary ownership of SIIP still rests with the Associate Dean for Undergraduate Programs, but the day-to-day operations of SIIP have been entrusted to AE3. All members of AE3 attend the weekly leadership team meetings of SIIP. AE3's leadership has been supplemented with the inclusion of STEM education researchers from various departments and programs such as our Physics Education Research group and the Illinois Foundry for Innovation in Engineering Education. Finally, we instituted rotating dean positions called Education Innovation Fellows (EIFs). EIFs conduct technical research and are tenured engineering faculty members who have a track record of a commitment to improving engineering education but are also well respected in their departments for their research contributions. Four EIFs serve on the leadership team for at most two years (see Table 1). These EIFs have been vital in providing a deeper understanding of faculty motivation and how faculty would perceive the policies and procedures of SIIP. These EIFs also serve as ambassadors for SIIP, championing support for SIIP in their departments and in the college.

Critically, EIFs provide a sense of representation for research faculty in the decision making of SIIP. Decisions about policies for education innovation are directed not just by administrators or "education people," but also by research-focused faculty. When policy changes were proposed such as the introduction of new evaluation criteria and the use of pre-proposals, these EIFs provided critical language for communicating about these changes in policy and for shaping the ultimate structure of these new policies.

3.2 Integration of the Leadership Team into Weekly Innovation CoP Meetings

As we described in previous publications, we observed that some 2012–2013 SIIP innovation CoPs had successfully managed to create communal buy-in and transferal of course designs and teaching practices across multiple instructors, while other CoPs progressed through fits and starts with each new instructor developing their own course designs and teaching methods,

TABLE 1. LIST OF EDUCATION INNOVATION FELLOWS BY YEAR

2013–2014	2014–2015
Matthew West	Matthew West
Jose Mestre	Jose Mestre
Rohit Barghava	Luke Olson
Larry Fahnestock	Dallas Trinkle

rejecting the developments and investments of previous instructors. Based on our observation that successful 2012–2013 SIIP CoPs met on a weekly basis, we created a new policy in Fall 2013 that faculty reform CoPs must meet on a regular (ideally, weekly) basis. This policy change was met with a mixture of hostility or ambivalence by some CoPs, but was welcomed by the majority of CoPs. As a concession for making mandatory weekly meetings, we decreased the number of SIIP-wide meetings to two per year. To ensure that these weekly meetings did not simply become a hassle, we focused on ways to create new value for CoPs through these weekly meetings. This goal led to the embedding of at least one member of the SIIP leadership team into each of the innovation CoPs. The resulting increase in manpower needs led to the creation of the EIF role. The embedding of leadership team members into the innovation CoPs provides three primary benefits: 1) cross-pollination of ideas and practices across CoPs, 2) just-in-time faculty development, and 3) representation of each CoP during policy decisions.

Because each leadership team member was embedded in multiple innovation CoP meetings as well as the weekly leadership team meetings, embedded leaders became the conduits for sharing best practices among CoPs. This function is most readily apparent in the spread of context-rich collaborative problem solving (CCPS) methodologies across SIIP (See Figure 3) [3]. Dr. West (an EIF) first learned about CCPS when co-teaching an engineering section of *Calculus II*. He pioneered the use of CCPS in Theoretical and Applied Mechanics (TAM) 212—our *Dynamics* course. He promoted the teaching practice among other TAM instructors and the practice spread to *Statics* and *Mechanics of Materials* through the TAM CoP (seven faculty members). Dr. Herman served as the integrated leadership team member for TAM during 2013–2014 and translated the use of CCPS to the Electrical and Computer Engineering (ECE) course *Intro to Computing* and is now leading the effort to integrate the practice into the *Intro to Electronics* course. The ECE CoP has had a variable membership but nine faculty will have experienced the teaching method within the year. Inspired by the success of TAM, Dallas Trinkle (another EIF) championed the translation of CCPS into the Materials Science and Engineering (MatSE) Mechanics for MatSE course. The integration of CCPS into this course led to the formation of a MatSE CoP (six faculty members) that trans-
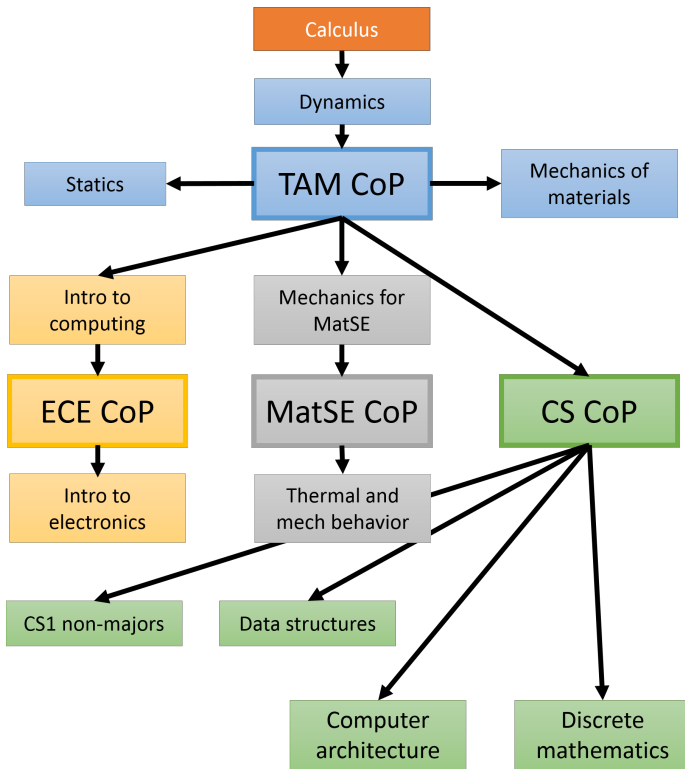
FIGURE 3. SPREAD OF COLLABORATIVE LEARNING FROM THE CALCULUS II COURSE ACROSS SIIP AS PROMOTED BY EMBEDDED EDUCATION INNOVATION FELLOWS. THIN BORDERS DENOTE INDIVIDUAL COURSES. THICK BORDERS INDICATE COMMUNITIES OF PRACTICE (CoPs). ARROWS INDICATE THE DIRECTION OF SPREAD.

lated the practice to the Thermal and Mechanical Behaviors of Materials course. At the same time, Dr. West was attending the weekly meetings of the Computer Science (CS) CoP (five faculty members). He shared his experiences with the CS CoP and guided their integration of CCPS into four of their courses. This spread of CCPS can be directly mapped to the embedded participation of the leadership team in multiple innovation CoPs.

By embedding leadership team members into innovation CoPs, we are also able to provide just-in-time faculty development. As we have previously discussed, many faculty have little or no prior experience with the rigorous evaluation of their teaching efforts. During weekly meetings, embedded leadership team members help faculty develop student surveys, negotiate research-based course policies, and connect faculty with others who have previously successfully accomplished target innovations of the CoP.

Finally, in accordance with change theory, embedding leadership team members into CoPs has created a greater sense of representation during decision making. This sense of represen-

tation was particularly critical when we changed policies to introduce mid-year project evaluations and pre-proposals. Existing innovation CoPs expressed significant concerns about the change in policies and fears about their ability to maintain funding under the new policies. We were able to allay these fears by positioning the embedded leadership team member as an advocate for the CoP during evaluations. The leadership team member helped guide each CoP through their self evaluations and helped the CoPs identify those practices which they had been doing well. Mid-year evaluations were positioned then as formative, collaborative endeavors to maximize performance rather than punitive or coercive structures designed for the leadership team to get its way.

3.3 Community-Centric Evaluations

After we had instituted the policy to require weekly CoP meetings with embedded leadership team members, a number of the innovation CoPs rejected the policy and continued to work as loose collections of independent faculty. The EIFs provided key insights into how the existing structure of granting funds with no formal evaluation process created a sense of entitlement among the recipients to do whatever they wished with the money. Expenditures of SIIP money were not spent as promised or without promoting community. For example, faculty would take summer salary from SIIP funds even though they did not work on any course innovations. Consequently, during Fall 2013, we developed project evaluations that focused on promoting collaborative, joint-ownership and implement-evaluate development cycles. These evaluation criteria were first used as a mid-year review of SIIP projects at the end of Fall 2013. These criteria also became the review criteria for funding decisions for new and renewing projects starting in Spring 2014.

We identified five categories of review criteria in addition to an overall rating: 1) administrative (departmental) support, 2) collaborative development and ownership of innovations, 3) faculty outcomes, 4) student outcomes, and 5) sustainability and trajectory. Innovation CoPs performance in each category was scored on the following five-point rubric.

O - Outstanding: Work was outstanding on all criteria. The team's methods and outcomes deserve recognition.
C - Commendable: Work was consistently above the requirements in most areas. While the team has a few areas to work on, their commitment and contributions are appreciated.
S - Satisfactory: Work met requirements in most areas, but improvements can be made. The team should continue their efforts.
I - Improvement Required: Work meets only the most basic requirements of the project. While the team may have performed acceptably in most areas, performance should be improved.

N - Not Acceptable: Work is below basic requirements in the critical aspects of the project and immediate improvement is required in consultation with leadership personnel.

Below is the explanation of each of the review criteria that we provide to the innovation CoPs. We describe the rationale for these categories in the following subsections.

1. There is strong, ongoing, visible, and consequential **administrative support** for the team.

   (a) The administration publicly creates and reinforces messages of support for creating a culture of continuing, evidence-based improvement.
   (b) The administration is institutionalizing instructional change (e.g., rearranging teaching assignments, creating new positions).
   (c) The administration is promoting faculty participation in innovations (e.g., release time, counting involvement as service, and other rewards for participation).

2. There is genuine commitment among participating faculty to the **collaborative development and ownership** of innovations.

   (a) Well-functioning and internally supportive faculty communities are initiated, nourished, and maintained in each participating department.
   (b) There are established and accepted expectations for ongoing engagement of all team members, e.g., attendance at and active participation in regular meetings among all faculty committed to the innovation (members of the team), including those who are not teaching that semester.
   (c) Multiple faculty collaborate on determining and shaping each innovation.
   (d) Change decisions are consensually made by the team or a subgroup thereof, and are well documented.

3. Valued **faculty outcomes** are attained.

   (a) Faculty are adopting evidence-based teaching methods and have explicitly agreed to continue using evidence-based methods as members of their team.
   (b) The evidence supporting innovations is well documented and is supported by all team members.
   (c) The team displays a commitment to collecting and using ongoing evaluative feedback toward continuous improvement of their own functioning and of the innovation.

4. Valued **student outcomes** are attained.

   (a) Participating students (particularly underrepresented populations) demonstrate engagement in the learning opportunities provided by the innovations, at levels above those prior to this intervention. Engagement includes active participation in learning, motivation to succeed, confidence in learning, and satisfaction with the learning experience.
   (b) Participating students demonstrate improved learning outcomes, at levels above those prior to this intervention.
   (c) Recruitment and retention of students in targeted STEM fields is improved, especially students underrepresented in STEM fields.

5. The team's interventions are **sustainable** and/or have a positive **trajectory** toward sustainability.

   (a) There is integrity of teaching methods across semesters, enabling evaluation and evidence-based modification of methods and content.
   (b) Innovations can survive changes in leadership, instructors, or funding.
   (c) Innovations in courses are making those courses more attractive teaching assignments.
   (d) The team is demonstrating improvement in any or all of the other metrics.

Administrative Support.   In order for faculty to successfully create collaborative, joint ownership of their innovations, departmental administrators need to provide innovation CoPs with sufficient resources such as control over how courses should be structured (i.e., how many lectures, discussion sections, and laboratory sections), course assignments that align with the innovation effort, and visible positive support for the effort within the department. Examples of positive administrative support include the allocation of an additional graduate teaching assistant to support new innovations and supporting efforts to design new instructional spaces that better support better teaching practices. Examples of inappropriate support include decisions to assign instructing faculty to a course who are not members of the CoP and have not agreed to the mission of the CoP.

Collaborative Development and Ownership.   We elevated collaboration to its own review criterion to emphasize the central importance of this behavior. The evaluation language was crafted particularly to combat situations in which a single, strong faculty member domineered decision-making processes. These situations were usually sparked by differences in academic rank. Compliance of community members is not a satisfactory replacement for collaboration.

Faculty Outcomes.   This review criterion was implemented to communicate the importance of the implement-evaluate development cycle and reinforcing the message of "teach like we do research." As we show in Figure 1, creating cultures of collaboration is only the first transformation in successful reform. The process of implementation and evaluation holds the innovation CoP to a higher standard and focuses the community's

efforts. Critically, the review criterion focuses on the innovation CoP's commitment to conducting evaluation and not necessary on the quality of evaluation. Given that most of the faculty are still learning how to conduct good evaluations, we intentionally provide space and time for the faculty to learn and grow in their methods.

Student Outcomes. Following our transformation model in Figure 1, the final stage of transformation is the implementation of RBIS that lead to improved student outcomes such as engagement, learning, and persistence. While the long-term goal of SIIP is to improve student outcomes, our evaluations are more holistic, aiming to create a teaching culture that can sustain improved student outcomes.

Sustainability and Trajectory. Large gateway courses, which have been a primary focus of SIIP, are often characterized as courses which the students don't want to take and the tenure-track faculty do not want to teach. Before SIIP most of the courses targeted for innovation were course assignment nightmares. Some departments simply resorted to finding peripheral lecturers to cover the assignment (we do not mean to imply that lecturers are inferior instructors, but rather focus on the lack of willingness of faculty to teach the course) while others used creative forms of conscription of faculty such as creating established faculty rotations that kept any one faculty from having to teach the course more than once every few years. In response to these difficulties, we challenged innovation CoPs to design their innovations to make their courses more attractive teaching assignments.

Aside from the logistical challenges of coping with large enrollments reaching upwards of 500 students per course, a primary challenge of the old models of course management across semesters comes from the content bloat that frequently accompanies changes in instructor. Each instructor brings their own perspective on the course material and adds new content that they deem important but fail to take any content out. Eventually the amount of content that "needs to be covered" becomes just as an unmanageable as the number of students. Thus a major goal of collaborative, joint ownership is to combat this type of content bloating.

Finally, during the first year of SIIP, we observed several faculty members develop innovative course materials and pedagogical tools that were immediately abandoned the following semester as a new instructor rotated into the course. Alternatively, course materials were used but not in alignment with the principles that motivated their use, decreasing the effectiveness of the innovation. This criterion was also intended to combat this type of wasted effort.

3.4 Pre-Proposal Evaluation

After creating the review criteria, we implemented a pre-proposal review process as a low-cost method for acclimating faculty to the new review process. Two-page pre-proposals for new projects are due in early March and final full proposals are due six weeks later in mid May. The pre-proposal process comes with an expectation for proposal teams and a commitment from the leadership team. Proposal teams are expected to meet regularly during the pre-proposal period to refine their proposal ideas, develop the CoP that will execute the innovation, and develop an evaluation plan. A member of the leadership team is embedded into the proposal team to facilitate the development of an evaluation plan, maximize the proposal's chance for funding, and connect the proposing team to existing SIIP teams or other resources that can provide advice and guidance. The expectation of this process is that by the end of the six weeks both the proposing team and the embedded leadership team member will know whether the proposal will be funded. By co-developing the proposal with the leadership team, the proposal team is welcomed into the SIIP community and develops a sense of being represented in the decision making process for funding. This sense of representation in decision making promotes the desire to go above and beyond the expectations of the effort.

At the end of the pre-proposal phase, the full proposal and the proposing team's initial performance are evaluated according to the criteria outlined in the previous section.

4 PROGRAM EVALUATION

To date, SIIP has funded 17 projects (See Figure 4). We have classified these projects as having three different focuses: 1) pedagogical focus, 2) innovative curriculum focus, and 3) instructional technology focus. Pedagogically focused initiatives (11 projects) focus on revising the content and teaching methods of courses. Innovative curriculum focused initiatives (two projects) focus on creating alternate conceptions of the undergraduate curriculum. Instructional technology focused projects (four projects) develop new teaching technologies that are not targeted at a specific course. Funding for projects persists for at most three years. Note that the failure of a project to receive funding for three years is not an indication that the project failed or was rejected for renewal of funding. Some projects became self-sustaining before they completed their three years of funding and voluntarily withdrew for funding.

4.1 Success Rate of SIIP projects

For funded projects, we consider successful SIIP projects to be those projects that earned overall ratings of "Satisfactory" or higher and were thus eligible for renewal. After the 2013–2014 school year, eight and a half projects received satisfactory ratings, meaning three and half projects were not invited for re-

newed funding. Although sharing the same funding account, one SIIP project split into two separate smaller CoPs focused on two different courses. These sub-CoPs did not interact with each other and did not pursue similar teaching methods. This split within the funded projects created the half-successful project as each of the sub-CoPs were evaluated separately. The successful sub-CoP was invited to submit for renewal whereas the unsuccessful CoP was not invited to resubmit for renewal.

Projects that were rejected for renewal all lacked collaborative, joint ownership of the innovation and failed to provide any evaluation evidence. Without evidence for success in achieving their objectives, these projects were rejected.

For the 2014-2015 competition six new SIIP were evaluated by the pre-proposal process. Two of the proposed projects progressed through the process with excellent reviews and only minor modifications. Because of difficulties in forming community, two proposed projects were led to dramatically change their memberships and project scopes to become competitive for funding. One proposed project was granted an extension in preparing for their final proposal and was given conditional funding. One proposed project never formed a committed community of faculty and was rejected from funding.

At the 2014-2015 mid-year reviews every SIIP project was in good standing having received a "Satisfactory" rating or higher. Every project has also been invited to submit for renewal of funding. Implementation of the pre-proposal process has improved the success rate of proposals, creating more projects that demonstrate collaborative, joint-ownership of reforms and a commitment to an implement-evaluate development cycle.

4.2 Number of Departments with Active SIIP Projects

Engagement with SIIP across the college has steadily grown each year. In 2012-2013, five departments participated in SIIP and there were no interdepartmental projects. In 2013-2014, two new departments participated in SIIP and there were two interdepartmental projects. In 2014-2015, two more departments participated in SIIP and there were two more interdepartmental projects (one which reached across multiple colleges). Pre-proposals for 2015-2016 now represent two more departments that want to participate in SIIP, leaving only one department in the college that has not applied for SIIP funding. This increased participation is a reflection of increased interest and excitement in the program.

Beyond increasing the participation of engineering faculty in education reform, SIIP is expanding to other colleges. With funding from NSF (DUE 134722), four departments from the College of Liberal Arts & Sciences (Chemistry, Integrative Biology, Molecular and Cellular Biology, and Geology) have begun to create communities of practice for reform.

4.3 Publications and Grant Proposals

SIIP has led to dramatically increased education-focused publication in conferences and journals as well as grant proposals. Notably most of these publications and grant proposals include faculty who had never previously prepared education related articles or grant proposals.

SIIP has generated four journal articles [17–20] and ten peer-reviewed conference papers [3, 21–29]. Fifteen of these authors had never previously published on their educational efforts.

SIIP has led to the submission of eleven grant proposals for external funding. Four proposals have been funded for a total of $3.3 million (NSF EEC 1429348, NSF DRL 1252389, NSF DUE 1347722, NSF IIS 1441149). The remaining proposals are still pending review. Eight of the PIs and Co-PIs on these proposals had never submitted education-related proposals prior to SIIP. Three of these PIs have now become first time recipients of external funding for education research and reform efforts.

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Projects funded starting in 2012		
Course/Technology	Description of Reform Effort	Status
Systems Engineering and Engr Risk	Improve student engagement by integrating video lectures, classroom response systems, and mini-projects.	Ended 2014
Computer Engr Core	Reorganize curriculum to modernize course content and integrate more laboratory experiences and active learning experiences.	Ended 2014
Computer Science Core	Develop tools and mechanisms to identify at-risk students earlier and enable instructors to provide remediation.	Ended 2014
Engr Mechanics Core	Improve student engagement by using collaborative, context-rich problem solving sessions, online simulations, and faster feedback.	Ends 2015
Student Test Prep in Physics	Identify students with poor study habits and provide additional structure to help those students.	Ends 2015
Projects funded starting in 2013		
Pedagogy-focused initiatives		
Civil Engr Projects	Create a project-based learning course that enables students to explore different areas of civil engineering.	Renewed
Building Information Modeling	Create alternate Building Information Modeling track for civil engineering students in Engr Design course, using flipped classroom.	Ended 2014
Systems Modeling and Control Systems	Create context-rich and visually-rich examples and simulations for students to learn fundamental concepts.	Ended 2014
Mechanical Design	Integrate project-based learning into mechanical design courses.	Renewed
Instructional-technology-focused initiatives		
Adaptive Learning	Create an adaptive learning platform based on machine learning algorithms.	Ends 2015
Engr Simulations	Create a cloud-based platform to host simulation tools based on industry software.	Ended 2014
Sketch-Based Homework System	Create a homework assignment platform that provides automated feedback on students' sketches of engineering diagrams.	Ends 2015
Projects funded starting in 2014		
Pedagogy-focused initiatives		
Introduction to Electronics	Reimagine the core course content to better align laboratory and lecture content. Create discussion sections to promote persistence.	Renewed
Computation modules in MatSE core	Integrate computational modules across the MatSE undergraduate curriculum and integrate best teaching practices.	Renewed
Innovative-curriculum initiatives		
Cancer Scholars ugrad research community	Create an undergraduate research community around the grand challenge of curing cancer.	Renewed
Global technologies minor	Provide experiential learning experiences that will create global citizens with strong technical skills.	Ends 2015
Instructional-technology-focused initiatives		
Computerized-testing facility	Construct a pilot testing computerized-testing facility that provides flexible testing and learning analytics.	Renewed

FIGURE 4.   LIST OF FUNDED PROJECTS BY YEAR, THEIR CATEGORY OF FUNDING, AND THEIR CURRENT FUNDING STATUS

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