

NSF Annual Project Report

NSF Award # 1525775

Title: *Collaborative Research: Deep Roots: Wide-Spread Implementation of Community-Driven Evidence-Based Pedagogy*

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I. ACCOMPLISHMENTS

A. What are the major goals of the project?

Collaborative Research: Deep Roots: Wide-Spread Implementation of Community-Driven Evidence-Based Pedagogy, is a collaboration across seven institutions, led by the University of Kansas (KU) and including four additional US institutions (University of California-Davis/UCD, University of Colorado Boulder/CU, Indiana University Bloomington/IUB, and University of Texas-San Antonio/UTSA), and two Canadian partners (Queens University/QU, and University of British Columbia/UBC). The network is implementing a model of STEM education improvement that builds on the successful Science Education Initiative (SEI) from UBC and CU. The model centers on the development of “embedded expertise” in STEM departments, with a focus on course transformation, to catalyze changes in teaching practices and culture. Our extension of the SEI model, which was piloted at KU prior to NSF funding, supports change with a smaller infusion of resources (i.e., fewer experts in a given department) by explicitly building communities of scholars within and across departments, and across institutions, to share in the development of course reform. The major goals are to:

1. Promote widespread adoption of empirically-validated instructional approaches in undergraduate STEM courses, and thus improve learning and educational outcomes for both STEM students and non-STEM students.
2. Determine if the intervention model can be adapted and implemented in different educational and institutional contexts to propagate improvement in STEM teaching and learning.

Reflecting these goals, we are using the acronym **TRESTLE** (Transforming Education, Stimulating Teaching and Learning Excellence) as the name of the network.

B. What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities

Goal 1: Promote widespread adoption of empirically-validated instructional approaches in undergraduate STEM courses

In Year 2, each TRESTLE institution continued to implement a program that incorporates these activities:

1. Embed experts to catalyze department-level course transformation.

- Campuses continued or enhanced existing programs of department-embedded experts (KU, UBC, UCD), or used funds to add faculty leaders (CU, UTSA, IUB) or postdoctoral scholars (QU).

2. Build communities of scholars around evidence-based course-reform.

- Each campus supported communities within and across departments.
- Program leaders from each campus met online every other week.
- The "TRESTLE Network Meeting" met in October 2016 at CU. Each campus sent one to five faculty/staff.
- Launched two types of virtual meetings: network-wide *TRESTLE Brownbags* for embedded experts and faculty, and virtual *TRESTLE Colloquia* to permit one campus to showcase and get feedback on local course transformation work. We hosted 7 Brownbags and 2 Colloquia, with over 100 total participants.
- We designed a new website, www.trestlenetwork.org, to enhance development of the TRESTLE community.

3. Generate evidence and accessible documentation of the methods and impact of course transformation within the communities.

- Documenting and sharing course innovations and results for student learning was a major activity on each campus.
- The TRESTLE network meeting and virtual colloquia are organized around evidence of how course transformations affect student learning and success.
- The TRESTLE website has a section for each campus to share their course transformation strategies and student learning results.

Institution-Specific Intervention Activities. Each institution adapted the above named interventions to their local context. Campus-specific activities are listed below:

University of Kansas. In KU's ongoing initiative, 1 postdoctoral teaching fellow (TF) worked in each of six STEM units. The C21 Consortium met regularly, and showcased course transformation efforts in an annual poster symposium. Several grant-supported activities enhanced the initiative:

- Hired a new Course Transformation Program Manager (May 2017) to coordinate KU and TRESTLE programs.
- Supported three graduate student fellows (GSFs) for C21 faculty support, and three undergraduates to make COPUS (Classroom Observation Protocol for Undergraduate STEM) observations and generate reports.

- Convened TFs and GSFs weekly for training and development.
- Awarded 6 course transformation grants (\$1000 to \$3000) to 22 faculty working on 9 courses. Awarded \$5000 travel grants to two faculty teams to see course redesign on another campus.

Indiana University, Bloomington. UIB is developing faculty leaders in one department and integrating them into their existing Course Development Institute (CDI) and Decoding the Disciplines Faculty Learning Community (DtD FLC). Activities include:

- Summer/Fall 2016 participants attended TRESTLE network meeting.
- Hired three undergraduate students to perform COPUS observations on Computer Science faculty participating in redesign.

University of California, Davis. UCD is looking at how teaching stream faculty (LPSOEs) foster educational change in their departments. Activities included:

- Three LPSOEs enhanced their professional development through the TRESTLE Annual Meeting and virtual network activities.
- The LPSOEs promoted educational change through multiple mechanisms, including creation of co-courses to support underprepared students, and creating discussion sections and TA training programs.
- Identified a new staff member to coordinate local engagement with TRESTLE.

University of Colorado, Boulder. CU's activities leveraged existing expertise generated through the SEI to foster course transformation activity, and provided opportunities to spread expertise:

- Implemented a Course Transformation Awards program, with \$10,000 grants for faculty with course transformation experience, and a \$1000 Mini Stimulus Grants for smaller pilot projects.
- Established *TRESTLE Scholar* communities; semester-long learning communities, led by experienced faculty, to support deeper faculty learning around evidence-based teaching.
- Established the *Shared Innovation Discussion Group (ShInDiG)*, a drop-in community for STEM faculty on implementing evidence-based teaching.
- Established the *Educational Advisors Program* to connect STEM educational experts and STEM faculty.
- Identified an advisory board and created public presence through a CU TRESTLE website, brochures, and emails.

University of Texas, San Antonio. UTSA's activities support faculty leaders in the College of Engineering (CoE), and leveraged STEM education experts in the College of Education and Human Development (COEHD):

- Recruited course redesign proposals and selected BioMedical Engineering and Electrical and Computer Engineering departments (and continued work in Civil

and Environmental Engineering), developed and implemented course transformation plans.

- College of Education and Human Development (COEHD) faculty collaborated with engineering faculty across three target departments.
- Established a cross-department learning community on course transformation (ACT- Advocates for Course Transformation) modeled on KU's C21.

Queens University. QU's course transformation efforts are catalyzed by postdoctoral teaching fellows (TFs). KU used NSF funds to hire a TF to work in the QU Physics department. QU faculty and TFs engage with TRESTLE through travel to network meetings and web-based interactions and resources. Activities include

- The Physics TF collaborated with faculty to redesign lab courses.
- Conducted teaching observations with the LOPUS (adaptation of COPUS for labs) and provide faculty feedback.
- Convened a cross-department community on STEM teaching innovation, including faculty and a TF hired by QU for the Electrical and Computer Engineering Department, who are redesigning lab and lecture courses.

University of British Columbia. As a mentor and comparative institution, UBC continued its SEI, with 8 Science Teaching and Learning Fellows (STLFs), convened a STLF community, and hosted an annual campus-wide symposium to showcase methods and results. The grant supports UBC STLF and faculty engagement with the network. Contributions include:

- Collaborated with network on operations and evaluation of model. Significant collaboration with KU to refine training and data collection processes for COPUS. Updated training materials will be available on TRESTLE website in 9/2017.
- Delegation to October 2016 annual meeting contributed talks and led sessions.

Goal 2: Determine if the intervention can be adapted and implemented in different contexts

1. Data Collection. In Fall 2016 and Spring 2017 five campuses collected:

- COPUS observations on courses included in the transformation effort and comparison courses.
- Survey of teaching practices for faculty teaching courses in the transformation effort and a randomly-selected sample.
- Syllabi for transformed and comparison courses.
- Department reports of progress on course transformation and faculty involvement.

2. Case Studies. Consultants Mary Huber and Pat Hutchings completed a baseline case on the IUB Computer Science Department in Fall 2016, and a mid-project case study in KU Biology in Spring 2017.

3. External Evaluation, provided by the National Center for Higher Education Management Systems (NCHEMS). NCHEMS staff (Peter Ewell or Marianne Boeke):

- Participated in all meetings and email communications.
- Gathered feedback from Annual Meeting participants and shared results with project leaders on all campuses.
- Gathered feedback from TRESTLE campus leaders on project activities, impact, and network functionality in Summer/Fall 2016 and produced a Yr 1 report Fall 2016. Gathered feedback in Summer 2017 to produce a Yr 2 report. Both reports are appended.
- Served as a sounding board to PIs for continual improvements.

Specific Objectives

The specific objectives within the two major project-wide goals are listed below. Some are the same as in Year 1, others have changed to align with Year 2 plans.

Goal 1. Promote widespread adoption of empirically-validated instructional approaches in undergraduate STEM courses, and thus improve learning and educational outcomes for both STEM students and non-STEM students.

1. Catalyze and support department-level planning and transformation of undergraduate STEM courses through faculty collaboration with department-embedded experts who bring pedagogical knowledge and practical support and encourage reflective teaching.
2. Amplify catalyzing effects by building intellectual communities, within and across departments and across institutions, that engage more people and support reflective practice and a shared vision for teaching.
3. Develop reflective teachers who use evidence to guide continuous improvement and work towards measurable goals by asking faculty within the communities to gather and share evidence of student learning.

Goal 2. Determine if the intervention model can be adapted and implemented in different educational and institutional contexts to propagate improvement in STEM teaching and learning.

1. Implement campus-specific interventions adapted to align with goals, existing resources, and climate at each institution.
2. Gather common measures across the network to track changes in teaching practices, attitudes and climate, and student successful course completion, and evaluate the success of the overall model and its localized adaptations.
3. Use project leaders network to regularly pool and synthesize findings across institutions, and learn from each others' successes and failures.

In addition, specific objectives of the NCHEMS evaluation were to:

1. Adjust the project approach to increase network functionality and effectiveness.
2. Gauge project success.

Institution-Specific Objectives: Each institution also has its own campus-specific objectives:

University of Kansas. KU began to implement the TRESTLE model prior to this grant. The grant enables KU to enhance, expand and improve that work, evaluate the impact on teaching and learning culture, and test the generalizability of the model to other campuses. Specific objectives are to:

1. Increase the support and productivity of our embedded experts (Teaching Fellows) by hiring a Course Transformation Program Manager to coordinate central activities and professional development, and by expanding their network beyond KU to generate the critical mass of educational experts found to be important in the CU/UBC SEI model.
2. Expand membership and activity of the C21 Consortium through course transformation grants and travel grants for faculty teams, and support from graduate student fellows.
3. Motivate additional change, foster cross-institution peer collaboration, and shift faculty perceptions of social norms around teaching by promoting faculty engagement with the TRESTLE network.
4. Enhance all aspects of KU's course transformation initiative, from specific teaching and assessment strategies to strategies for leading and evaluating change, through cross-fertilization of ideas from TRESTLE institutions.

Indiana University Bloomington. The purpose of IUB's project is to combine the department-embedded expertise model with existing cross-department learning community efforts on campus, to transform the culture of teaching and learning within the Computer Science department. Specific objectives are:

1. Redesign courses using the backwards course design process fostered by the CDI, which focuses on aligning authentic assessments and grading rubrics with course goals early in the design process. Faculty systematically design courses to engage in students in transformative experiences resulting in deep learning.
2. In the CDI faculty design assessments to provide evidence that students have successfully achieved student learning outcomes.
3. During the TLC faculty create bottleneck lessons to provide explicit expert modeling for students in their courses and create assessments to determine the success of these lessons.

University of California, Davis. UCD's involvement in the project aligns with their LPSOE positions and their TEA (Tools for Evidence-Based Action) project, coordinated with their Center for Educational Effectiveness. Specific objectives are to:

1. Increase support for the LPSEOs and institutional impact of their educational change work through networking, professional development and collaboration opportunities in TRESTLE.
2. Study the multiple mechanisms through which the LPSOE's work leads to broader instructional change.
3. Facilitate data gathering and use of data in the TRESTLE network through tools that are a part of TEA, while also broadening the community of institutions and individuals utilizing these tools.

University of Colorado, Boulder. After CU's SEI ended, there was no formal mechanism for building on that work or the expertise developed. CU is leveraging the

SEI investment by using existing embedded expertise to deepen and broaden the use of evidence-based teaching practices. Specific objectives are to:

1. Provide opportunity for those with existing expertise to deepen and sustain their work, through course transformation awards, leading a Scholars faculty learning community, serving as an Educational Advisor, or engaging in ShInDiG.
2. Initiate new departments and faculty into evidence-based teaching through participating in Scholars or ShInDiG, applying for mini-awards, or consulting an Educational Advisor.
3. Forge strong connections between STEM departments, by engaging faculty across departments in the above opportunities, requiring collaboration in all TRESTLE projects, and publicizing the work across campus.

University of Texas, San Antonio. The purpose of UTSA's project is to launch STEM course transformation and capitalize on existing human resources in building faculty communities to improve teaching and learning in undergraduate engineering courses. Specific objectives are to:

1. Change the culture of teaching in engineering at UTSA by partnering curricular experts with pedagogical experts (from the College of Education and Human Development).
2. Develop a support system for University-wide cultural change in the approach to teaching at UTSA through the implementation of Learning Communities.
3. Contribute to the TRESTLE network with data, learning modules, and experiences to develop an implementation plan for a variety of institutions and with diverse student populations.

Queen's University. QU objectives are aimed at launching a STEM course transformation initiative organized around embedded expertise and community building:

1. Design a 3-year departmental plan for course transformations to address issues and needs identified within the departments.
2. Develop educational materials to improve student learning and tools to demonstrate student achievement of learning.
3. Enhance online course resources outside of class time and develop active learning activities to maximize concept mastery during face-to-face class and laboratory time.
4. Collaborate with others to measure the effects of these teaching interventions on student learning and faculty attitudes and teaching practices.

University of British Columbia. UBC is involved in TRESTLE as a mentor and comparative institution, with the goal of disseminating feasible adaptations of the SEI to other institutions and enhancing their implementation and evaluation of the SEI's efficacy on their campus. Specific objectives include:

1. Refine the Teaching Practices Survey instrument.
2. Refine COPUS training and documentation.
3. Create networking and leadership development opportunities for faculty and STLFs through engagement with the TRESTLE network.

4. Generate data and publications from Teaching Practices Survey.
5. Complete additional case study reports to provide more evidence of the impact of the SEI at UBC.

Significant Results

The major TRESTLE activities, combined with each institution's ongoing efforts, have begun to make headway on the two major goals.

Goal 1. Promote widespread adoption of empirically-validated instructional approaches in undergraduate STEM courses

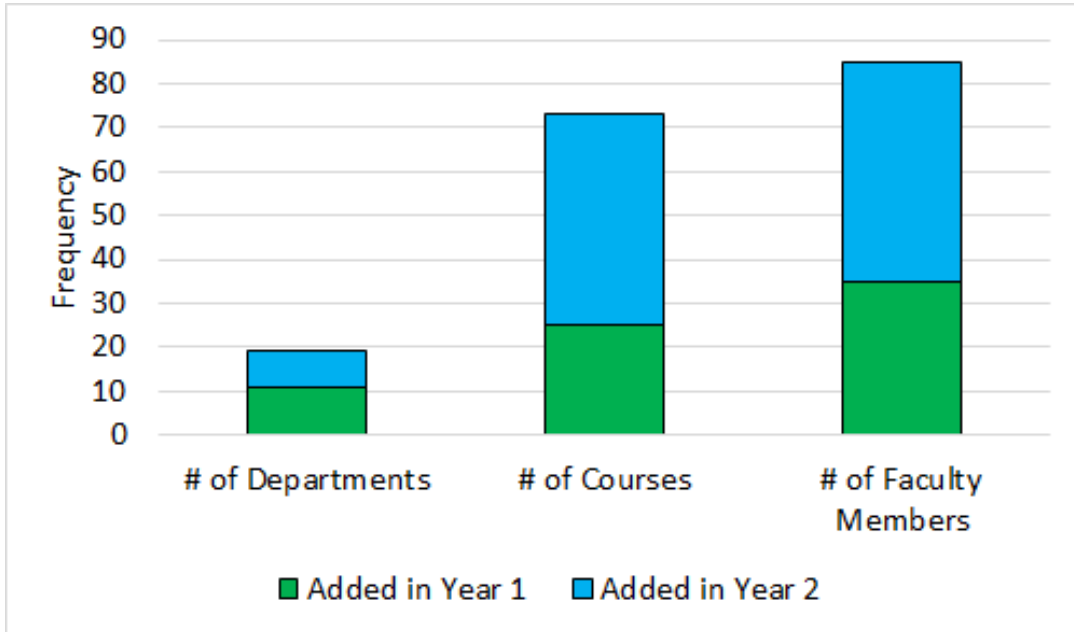
- Continued to generate course transformation activity and intellectual communities on each campus, involving multiple courses and departments (see Figure 1 below).
- Developed greater cross-institution community around teaching innovation through a series of virtual discussions for TRESTLE participants beginning in October 2016.
- Developed a website to provide access to shared intervention resources, make visible the course transformation work and results from each campus, and create an efficient network for communication within the TRESTLE affiliates.
- Developed detailed documentation and video training materials for COPUS observations.
- Fifty people attended the two and a half day TRESTLE Annual meeting at CU, including 45 faculty/staff from TRESTLE institutions (8 KU, 18 CU, 1 UTSA, 5 UBC, 3 UC-Davis, 4 Queens, 6 IUB) 3 participants from non-TRESTLE institutions (1 Washington Univ., 1 Oregon State, 1 Brown Univ.) and 2 outside evaluators.

Goal 2: Determine if the intervention can be adapted and implemented in different contexts to propagate improvement in STEM teaching and learning.

To gauge the success of the intervention we have collected data on course transformation activity, results and faculty participation; a faculty survey of teaching practices and attitudes; and classroom observations.

- Course-level and faculty-level reporting forms are used to track the amount and level of course transformation and faculty participation. To track course transformation activity, course-level reporting forms have been collected on 75 courses (32 KU, 12 CU, 7 IUB, 7 UTSA, and 17 QU). Faculty-level reporting forms have been collected on 85 faculty (34 KU, 19 CU, 7 IUB, 7 UTSA, and 18 QU).
- Collected course narratives, describing the impact of redesign on student learning and engagement, for 29 courses (16 KU, 4 CU, 3 IUB, 6 UTSA).
- In Spring 2017 the second wave of the faculty survey was deployed by five institutions and responses were received from 122 KU, 69 UTSA, 53 CU, 32 IUB, and 43 QU faculty.
- Collected COPUS data and syllabi from 76 course offerings at KU, 17 at CU, 8 at UTSA, 6 at IUB, and 15 at QU, each observed at least three times (per semester offering). (UCD and UBC data are not yet aggregated into the TRESTLE database.)

Figure 1. Growth of Course Transformation Activity on TRESTLE Campuses (Includes KU, QU, IUB, UTSA and CU)



Institution-Specific Results

University of Kansas

- Enhanced professional development and mentoring of the TFs via weekly meetings and participation in the TRESTLE Launch meeting. Six TFs each generated and assessed 2-3 redesigned courses in collaboration with department colleagues.
- Two travel grants (\$5000 each) for Engineering team to visit Purdue University and Biology team to visit UBC to observe teaching innovations.
- TRESTLE-funded Course Transformation grants totaling \$16,000 supported work of 29 faculty/staff on 9 different courses.
- Nine C21 meetings engaged 20-45 faculty, staff and students (STEM and non-STEM).
- A campus-wide poster symposium showcased course transformation efforts on 29 courses/sets of courses (10 STEM). Of the courses that had implemented the changes, 75% included student learning evidence, and 95% showed gains in student performance and/or that students achieved key learning outcomes.
- Generated classroom observation reports on 53 classes for the course instructors to prompt reflection about learning activities in their class.

Indiana University Bloomington

- Computer Science (CS) developed a plan for course transformation that reflected department/student needs and faculty commitment to redesign.
- Three CS faculty redesigned a course each with implementation and assessment plans to be carried out AY2016-2017.
- Four CS faculty are redesigning a course with implementation and assessment plans to be carried out AY2017-2018. They will teach and assess their redesigned courses in Fall 2017.

University of California, Davis

- The TRESTLE Annual meeting and the virtual meetings provided an occasion for three LPSOEs to network and engage in discussion of course transformation.
- Increased used of GORP tool and gathered feedback from the network about utility.

University of Colorado, Boulder

- Awarded **4 Course Transformation Grants** of \$10,000 each, to Math and Integrative Physiology in 2016 and Physics and Environmental Science in 2017.
 - o Math developed learning goals and structure for a new statistic-focused alternative to College Algebra, which was implemented in two pilot courses, and will be expanded to 15 sections in Fall 2017.
 - o Integrative Physiology developed an interrupted case study spanning 3 core courses.
 - o A Physics instructor redesigned the introductory labs with significant faculty engagement.
 - o Environmental Studies is designing a new introductory course using active

learning.

- Created **4 Scholars communities** led by experienced STEM faculty, focused on (1) program learning goals, (2) group work activities, (3) embedding metacognition into course activities, and (4) course based undergraduate research.
- Awarded **3 mini-grants** to support small or pilot projects in teaching and learning, including attending a workshop in geosciences and developing interactive approaches in computer sciences and mathematics.
- Continued the **Shared Innovation Discussion Group (ShInDiG)**.
- Held the **CU Annual TRESTLE Meeting**, for CU campus participants to meet one another, discuss the work and common challenges, and make connections.

University of Texas, San Antonio

- Developed a plan to redesign courses based on student performance (DFW rates).
- Three COEHD faculty members and a doctoral student worked with faculty on course transformations with four CEE faculty from the previous iteration of course transformations in ACT, and two new teams of faculty from ECE (6 faculty) and BME departments (2 faculty members and a TA). These faculty teams competed and received \$10,000 award for activities.
- Embedded faculty members designed a new observation protocol, still to be tested, to accompany the COPUS that addresses student engagement/motivation and culturally responsive pedagogical practices.
- The ACT learning community has grown to monthly meetings with 18 faculty members across UTSA.

Queen's University

- The NSF-supported TF in Physics worked with 10 faculty and 11 students to transform from traditional to design-lab model. To date, two courses have undergone significant change.
- The TF in Electrical and Computer Engineering launched the redesign of seven large courses.
- Participated in brownbag discussions and led the second virtual colloquia session in April 2017.

University of British Columbia

- Three faculty and another STLF had professional development, networking and collaboration opportunities through the 2016 annual meeting (Oct 2016).
- Participated in and led four of the TRESTLE brownbag meetings.
- Gathered data on faculty teaching practices and attitudes for internal and TRESTLE purposes.

Key outcomes or other achievements

TRESTLE-Wide Outcomes. At the end of the project's second intervention year, some important outcomes have been generated for the network as a whole.

- The TRESTLE network has developed a North American presence. Embedded experts or individuals leading similar programs at non-TRESTLE institutions participated in the 2016 annual meeting. The central TRESTLE website (www.trestlenetwork.org) provides numerous resources aligned with each component of the model, and makes visible the strategies and results of course transformations at TRESTLE campuses.
- Common data collection is beginning to drive decision-making for network activities and objectives.
- External evaluation provided valuable feedback for project improvement through participant surveys after face-to-face meetings, annual evaluation reports, and consultations across the year. Changes prompted by the Year 1 report include (a) increasing virtual network activities and resources for campus participants, (b) developing a resource- and example-rich website to foster greater identification with TRESTLE among campus participants, and (c) launching regular online colloquia for each campus to lead a “deep dive” discussion on their strategies and progress.
- People who are working with embedded experts for the first time are now receiving significant guidance and support from the network and web resources.

Institution-Specific Outcomes. Additional outcomes or achievements specific to each campus are outlined below:

University of Kansas

TRESTLE has increased visibility of and faculty engagement with course transformation and improved support for the embedded experts. Notable outcomes:

- Continued expansion of course transformation work on campus. The 2017 course transformation poster symposium showcased work in 14 different disciplines, on 29 courses, involving 52 faculty members, and affecting 6165 students.
- Increased focus on student learning results and documented gains in student learning.
- Creation of several promotable “teaching specialist” positions, modeled after UBC’s teaching professor track.
- Catalyzing effects on other KU initiatives: (1) AAU STEM Initiative Mini-Grant to support a KU Stem Analytics program that empowers faculty to use institutional data to identify courses to transform, and track downstream curricular effects of course transformation; (2) New collaborative NSF IUSE grant (DUE# 1726087) to support a project to improve teaching evaluation and increase recognition and reward of teaching innovation; (3) Expansion and coordination of models that use undergraduate teaching assistants to support active learning.
- Significant advances in change to two large-enrollment Biology majors courses, after 3-years of minimal change. Non-majors Biology also began the process of incorporating active learning methods.

Indiana University Bloomington

- IUB involved CS faculty in 2 long-standing successful campus faculty learning

communities, building a critical mass of faculty in a single department to generate and sustain cultural change.

University of California, Davis

UCD's focus this year remained on supporting its LPSEO program and providing support to the rest of the TRESTLE team regarding measurement plans. A key outcome has been inclusion of the LPSEOs in the TRESTLE network, adding to their effectiveness at UCD.

University of Colorado, Boulder

CU leadership has engaged and supported faculty and departments at varying stages of the change process to create community and spread expertise. New ideas have been generated and shared, several courses have been impacted, and new communities of faculty are deepening their pedagogical knowledge.

- **The TRESTLE Scholars groups have been highly successful.** Faculty applications for the communities has increased from 5 in 2016 to 14 in 2017, and we are struggling to meet the demand. Instead of the originally envisioned single faculty leader, we have engaged 2 faculty leaders to facilitate the groups given the greater size.
- **The course transformation awards have led to course improvements** with several departments incorporating evidence-based practices. The department with the most tangible results (IPHY) reports improved student performance on exams as a result of case studies.
- **A variety of departments have been engaged.** By design, the TRESTLE initiative allows faculty with expertise in active learning to deepen it, and departments and faculty with less expertise to get involved in educational innovations. PI Chasteen has made significant connections (as a non-embedded educational expert) with several departments who have been historically disconnected from the STEM reform community at CU, including ENVS, MATH, ATOC, and CSCI.
- **TRESTLE is enabling connections across departments**, including the TRESTLE national virtual meetings, the CU TRESTLE annual meeting, and the interdisciplinary Scholars and ShInDiG groups. Many course transformation awardees have also connected to others across campus as part of their change strategies.

University of Texas, San Antonio

- The CEE department has partially redesigned four courses to improve student learning, increase retention and graduation rates. CEE faculty now consider course redesign a normal part of their departmental activities. The engaged faculty are gaining confidence in their teaching abilities and have formed a significant new ally in the COEHD.
- A poster was presented at the annual meeting of TRESTLE at the University of Kansas describing the unique approach of partnering COEHD faculty with CEE faculty.
- There is potential for widespread transformation across the respective

departments. Current courses undergoing transformation follow one of two models: RECITE for EE and PALS for BME. RECITE, transforming recitation sections, for EE will affect four courses across the EE undergraduate program. The PALS, peer-assisted learning model, is currently being tested in a BME course. If successful, it will be implemented across the BME undergraduate program.

Queen's University

- Preliminary results from an E-CLASS survey indicate that students in the new design lab had a positive attitude shift towards experts, whereas those in the procedural lab did not have any shift. End of term survey results also show that the design students had a better learning experience.
- A 10% increase in the number of faculty who completed the attitudes and practices survey suggests that there is increased awareness of the TRESTLE transformation projects at QU.

University of British Columbia

- UBC input has resulted in restructuring of training programs for TFs at KU, influenced selection of course materials repository platforms, and guided selection of course observation protocols across the network campuses.
- Participation in TRESTLE has benefitted STLFS and teaching faculty at UBC through networking and opportunities to develop a broader audience for their work. For example, based on his contributions at the Launch meeting, a teaching faculty member and former STLF (Brett Gilley) was invited to KU to conduct workshops and advise department leaders and Teaching Fellows on leading and supporting department-level change.

C. What opportunities for training and professional development has the project provided?

TRESTLE-Wide Training and Professional Development

Training and professional development are central to TRESTLE operations. The project is specifically designed to provide opportunities for training and professional development throughout the multi-level communities on each campus and across-campus, for the embedded experts as well as faculty participating in the intellectual communities. The partnerships between embedded experts and their department colleagues also provide valuable opportunities for the transfer of pedagogical and disciplinary knowledge and skills (in both directions). The 2016 TRESTLE Annual Meeting (hosted by CU-Boulder) provided participants with opportunities to share course transformation activities occurring at the different institutions, as well as discuss results and sustainability efforts. Virtual meetings that are open to the general public were also hosted by the TRESTLE network, and included topics on departmental change, faculty development and leadership skills. The network itself creates opportunities for cross-institutional mentoring relationships that can provide a context for informal training and professional development. In addition to these common opportunities, we list specific training and professional

development opportunities that are provided on each campus below:

Institution-Specific Training and Professional Development

University of Kansas. A training and development program was hosted for the postdoctoral Teaching Fellows, consisting of weekly seminar-type meetings led by TRESTLE project leaders. This group has focused on ensuring that the embedded experts at KU are well-trained in the literature surrounding evidence-based teaching practices, have an opportunity to learn about shifting stakeholder attitudes and practices, catalyzing change, analyzing data, and preparing for various careers. Training is also provided to the GSFs, and weekly meetings are held for those students. The C21 Course Redesign Consortium provides training for TFs, faculty, students and staff (supported by the university, but enhanced via TRESTLE mini/travel grants and graduate student fellow support). Additionally, a joint training program was developed for undergraduate teaching fellows (UGTFs), who assist with implementing and scaffolding in-class active-learning exercises, in STEM departments this year. This spring 2017 UGTF training kickoff session included over 100 student, faculty, and embedded expert participants from engineering, geography, physics, and biology. Finally, a series of departmental-based learning communities were formed in 2016-2017 in engineering, chemistry, biology, and physics; these provided opportunities for learning to occur between faculty and TFs within departmental contexts. IUB's TRESTLE campus leader led an engineering workshop at KU on Decoding the Disciplines, which is synergistic with IUB's TRESTLE implementation.

Indiana University Bloomington. Faculty who are funded to take part in the TRESTLE initiative receive professional development and training in course design through existing programs (funded by the institution): (1) the Course Development Institute, a week-long course design program held by the IUB teaching center each June, and (2) Transformative Learning Collegium, a Decoding the Disciplines Faculty Learning Community, which includes multiple disciplines organized around transformative learning. IUB continued this year with the same approach, with only minor changes to the program.

University of California, Davis. The LPSOEs have participated in an ongoing LPSOE learning community to support their understanding of new pedagogies and strategies for course transformation.

University of Colorado Boulder. All activities of the grant provide substantial professional development for teaching faculty, including: (1) Course Transformation Grants, (2) TRESTLE Scholars Communities, and (3) the ShInDiG Learning Community.

- **Course transformation awards cultivate departmental change leaders.** In IPHY, the award recipients indicate that the award gave them a reason to work with faculty as they developed the case studies, and resulted in both student learning and changes in faculty behavior. These instructors have also participated significantly in the cross-campus opportunities to learn how to lead change in their department. In MATH, PHYS, and ENVS, the award is giving faculty and instructors a platform to work on course transformation activities, as well as helping bring visibility and recognition to that work.
- **TRESTLE Scholars gain expertise in teaching and learning.** Enrollment in Scholars has increased, and faculty participants respond positively ("Interacting with a diversity of faculty from all over campus is really enlightening," said one), and often request to continue meeting after the initial semester. Many

participants have enrolled in multiple Scholars communities, or engaged with TRESTLE in other ways.

- **TRESTLE Scholars Facilitators gain leadership and facilitation skills.** The Scholars faculty leaders have also benefited from the community, gaining experience and support in leading faculty development opportunities and taking on identities as change agents. Short written reflections from facilitators have been very valuable to future facilitators, and “Facilitator’s Handbook” has been written to capture the campus expertise that is being developed through Scholars.
- **ShInDiG supports cross-departmental sharing of ideas and resources.** The community has engaged faculty across several departments in sharing on-the-ground challenges and solutions to incorporating active learning.

TRESTLE is also providing professional development opportunities for faculty to serve as *leaders of change* – the Scholars program provides opportunity for faculty to lead their colleagues in exploring educational innovations (supported by meetings with the PI, “facilitator reflections” from previous groups, and a Facilitator’s Handbook.)

University of Texas, San Antonio. Faculty funded through TRESTLE, as well as other faculty, have been invited to participate in the new ACT learning community. The UTSA campus has also made connections between TRESTLE faculty and the Office of Online Learning and Office of Teaching and Learning to provide professional development and technical/instructional support. TRESTLE faculty at UTSA are helping to lead some activities that were discussed as part of ACT with the UTSA Office of Teaching and Learning at the UTSA Faculty Center.

Queens University. Queens created opportunities for professional development around teaching by convening the STEM-ED group for faculty interested in STEM teaching innovations. Survey responses from the first year of the TRESTLE project were presented as part of internal dissemination at the Queen’s STEM-Ed meeting to provide a discussion point for teaching practices.

University of British Columbia. TRESTLE participation created opportunities for educational leadership and networking for all UBC participants (such leadership is a requirement for tenure and promotion for teaching-stream faculty at the institution). More specifically, the Launch Meeting and Annual Meeting participants received practice in consulting on educational improvement as well as practice representing UBC’s teaching and learning accomplishments. Moreover, TRESTLE network engagement is resulting in invitations for more focused opportunities to consult with other TRESTLE institutions.

D. How have the results been disseminated to communities of interest?

Results have been disseminated in the following venues:

On-Campus Intellectual Communities. Results are being shared within the on-campus communities (e.g., KU’s C21 Consortium, CU’s Shindig, UTSA’s ACT, UCD’s LPSEO community, UBC’s STLF community, QU’s STEM-ED community, and IUB’s DCD faculty learning community) as part of their regular interactions. In addition, the work is being shared in departmental or cross-department colloquia on each campus, and KU and UBC have both held university-wide symposia to share course transformation results in specific courses and programs.

TRESTLE Annual Meeting. All TRESTLE network campuses presented a poster capturing work, progress, and status of course transformations at their institution at the TRESTLE Annual Meeting in October 2016. Additionally, an overview of network-level results-to-date was shared at the October 2016 Annual Meeting, including a summary of teaching practice survey results from the network institutions. Participants from the TRESTLE campuses also shared their work on course transformation at the Annual Meeting, by presenting either a Case Study, a Poster, or a “Quick Hit” (mini presentation).

TRESTLE Website. Resources and results are being shared globally through the TRESTLE website (www.trestlenetwork.org).

Publications and Presentations at National/International Meetings and Conferences. Project personnel and participants have engaged in scholarly dissemination of three categories of TRESTLE-related work: 1) Papers and presentations by project leaders/personnel sharing the methods and results of our work on institutional change, 2) Papers and presentations by project personnel and participants sharing methods and results of course transformation work that has been directly supported by these NSF-funds (e.g., through mini-grants, summer salary stipends, hire of postdoctoral fellow), and 3) Papers and presentations by project leaders and participants on course transformation work that is facilitated by TRESTLE engagement with no direct financial support from the NSF grant (e.g., participants in the broader on-campus communities or in the TRESTLE network). We include only the first two categories of presentations and publications in our list of Products in this report. The third category is admittedly more difficult to track, but we list those that we are aware of here.

1) The PIs and campus leaders have disseminated results from the early phases of our institutional change work at national/international meetings and conferences, including:

- Timothy Yuen (UTSA) presented a short paper on UTSA’s implementation of the TRESTLE program at the IEEE Teaching and Learning in Engineering conference in Bangkok, Thailand in December 2016.
- Andrea Greenhoot shared the results of TRESTLE efforts at the June 2017 meeting of the Bay View Alliance Steering Committee.
- Caroline Bennett and Andrea Greenhoot had a presentation accepted for the 2017 ISSOTL meeting in October. The paper focuses on quantifying the level of faculty engagement with various incentives and programs offered for course transformation in different department contexts.
- Mark Mort and Stephanie Chasteen submitted a proposal to the 2017 AAC&U STEM Transformation Meeting and will present a poster highlighting the efforts at KU and CU in November 2017.
- Andrea Greenhoot, case study consultants Mary Huber and Pat Hutchings, and external evaluator Peter Ewell collaborated on a submission to the 2017 AAC&U annual meeting (pending).
- The TRESTLE program manager (Blair Schneider) and campus leaders from KU (Mark Mort), UTSA (Tim Yuen), and QU (Natalie Simper) collaborated on a

submission to the 2017 AERA meeting (pending).

2) Project personnel and participants have also disseminated methods and results of the course transformation work that was directly supported by these NSF-funds.

- Bei Cai, the NSF-Funded Postdoctoral Teaching Fellow who is working at QU, presented her work on lab course transformation with QU colleagues at four physics education conferences in 2017 (see Products).

3) In addition, project leaders and participants have disseminated course transformation work that was facilitated by engagement with the TRESTLE network (e.g., participation in the on-campus or national community), but this work was not directly financially supported by the NSF grant:

D. Salem, "Innovation in Electrical and Computer Engineering", Queen's University, ECE departmental Seminar, Canada, Kingston, Feb. 2, 2017.D.

D. Salem, B. Frank, "The Role of Engineering Teaching and Learning Fellows in The Transformation Process of ECE Courses" Canadian Engineering Education Assembly, Toronto, Canada, June 5-7, 2017.

Bennett, C., Collins, W., & McVey, M. (2017). A Tiered Mentoring Model for Deepening Student Learning Across Undergraduate and Graduate Design Courses. In *Proceedings of the American Society of Engineering Education (ASEE) Conference*. (Refereed)

McVey, M., Bennett, C., Kim, J., & Self, A. (2017). Impact of Undergraduate Teaching Fellows Embedded in Key Undergraduate Engineering Courses. In *Proceedings of the American Society of Engineering Education (ASEE) Conference*. (Refereed)

Self, A., Johnson, H., McVey, M., & Bennett, C. (in press). Student Perspective of Pedagogies of Engagement. In *Proc., ASEE Midwest Section Meeting*. (Refereed)

Bennett, C., Collins, W., & McVey, M. (2017, June 28). *A Tiered Mentoring Model for Deepening Student Learning Across Undergraduate and Graduate Design Courses*. American Society of Engineering Education (ASEE) Annual Conference, Columbus, Ohio.

McVey, M., Bennett, C., Kim, J., & Self, A. (2017, June 25). *Impact of Undergraduate Teaching Fellows Embedded in Key Undergraduate Engineering Courses*. American Society of Engineering Education (ASEE) Annual Conference, Columbus, Ohio.

E. What do you plan to do during the next reporting period to accomplish the goals?

Goal 1. Promote widespread adoption of empirically-validated instructional approaches in undergraduate STEM courses.

Year 3 plans to accomplish Goal 1 are organized around the three components of the intervention model:

1. Embed Experts. In the next year, the TRESTLE institutions will be in the final year of the intervention period. All campuses will be actively intervening to produce course redesign on their campuses through targeted funding awards to departments and courses, through further development of training programs for embedded experts, and through cross-campus interactions and engagements.

- At KU, UBC, and UCD the embedded Fellows and departments with LPSEOs will continue the iterative process of working with faculty to transform courses and assess the results.
- KU will award another round of course transformation mini-grants and travel grants to continue to incentivize course transformation work.
- CU will award a third and final round of course transformation grants, and continue to offer mini-grants.
- The first cohort of CS faculty at IUB taught transformed courses and gathered evidence of student learning in Spring 2017. The second faculty cohort will teach and assess their transformed courses in Fall 2017, sharing results at a campus colloquium in Spring 2018.
- At UTSA, EE and BME faculty, in collaboration with their faculty partner in COEHD, will implement redesigned versions of the target courses developed in Fall 2017, and review results for iterative improvements. The EE and BME faculty are also planning to engage in educational research with our embedded experts on their course transformations with the goal of disseminating our results. Another department will be added this year.
- The Fellow in Physics at QU will continue collaborations with faculty to transform lab courses, joined by a Fellow hired to transform large courses in Electrical and Computer Engineering (latter supported by university funds).

2. Build Communities. All campuses will further develop and sustain learning communities around their embedded expertise models, with campuses that have maturing learning communities continuing to contribute experiences and lessons-learned to campuses with emerging learning communities (e.g., UTSA, CU). Two campuses will explore modifications to their local learning communities:

- CU is supporting two additional Scholars programs, one on course-based undergraduate research communities, and another possibly on assessment. CU is also exploring how to continue to engage these faculty past the initial intensive experience.
- CU is also continuing the ShInDiG group, and continuing to create a campus newsletter and post announcements to the internal email list.

- KU will broaden the reach of C21 through course transformation grants, and design C21 sessions to align with grants awarded. Department-level learning communities developed last year in engineering, biology, and chemistry will continue to mature.
- The terms of all but 3 KU TFs have ended, so we will transform their community to support both TFs and individuals in new Teaching Specialist roles.

We will also focus in Year 3 on strengthening the cross-institutional TRESTLE community:

- We will continue to expand inter-institutional collaborations, particularly between embedded experts and departmental faculty on different campuses. In late 2016 and early 2017, we initiated virtual seminars and brownbag discussions. We will continue to expand this form of cross-collaboration between the TRESTLE campuses.
- Convene the TRESTLE Annual Meeting in September 2017, hosted by IUB in Bloomington, IN. The September 2017 Annual Meeting goals are to: (1) analyze the reach and effects of course transformations occurring at the network institutions, (2) serve as an onboarding opportunity for network participants who are new to the course redesign community, (3) provide intentional opportunities for networking between TRESTLE participants to further develop cross-institutional collaborations, and (4) Disseminate the work more broadly to the IUB campus in support of broader cultural change beyond the Computer Science Program.
- We will increase emphasis on documenting student learning and assessment of course transformation reach and impacts.

3. Generate Evidence and Accessible Documentation. With course transformation efforts fully underway in Year 3, each institution's program has devoted greater attention to gathering and analyzing student learning evidence transformation activities to stimulate further uptake on their campus. Similarly, "TRESTLE Central" has focused on supporting such documentation and dissemination of TRESTLE activities and results. To this end, the 2017 Annual Meeting is designed to create "occasions" for participants to report out on their work in multiple formats ranging from 5-minute presentations to hour-long "deep-dive" breakout discussions to posters. The web presence is also being built out to facilitate dissemination, and to serve as a resource to non-network institutions also interested and involved in course redesign.

Goal 2: Determine if the intervention can be adapted and implemented in different contexts to propagate improvement in STEM teaching and learning.

1. Data Collection and Analysis. An emphasis on course-level, department-level, and network-level data collection was made in 2016-2017, and this emphasis will be carried through the next year. The survey of teaching practices and attitudes was administered for a second time in 2017, and course-level information was gathered from each of the seven institutions in the form of a spreadsheet. Course observations were continued in courses that are a part of transformation efforts as well as comparison courses. Cumulative COPUS/LOPUS observations and teaching practices/attitudes survey data were analyzed in Summer 2017.

Discussions of our Year 1 data highlighted the need for a formal definition of a "Transformed Course" that can be operationalized in terms of our outcome measures. Thus in Year 3 we will develop a rubric to assess the sophistication and depth of course transformation efforts, for the TRESTLE project and ideal for the broader community.

2. External Evaluation. External evaluation activities by NCHEMS accelerated in Year 2. An evaluation of the 2016 Annual Meeting was received from NCHEMS following the meeting, with the following highlights, which inform the plans for our 2017 meeting:

"Overall the workshop was well received by the participants. Respondents noted that the workshop was well organized, had interesting speakers and sessions, and allowed plenty of time for networking. As one respondent stated, "This was, without doubt, one of the most useful, most organized meetings that I have ever attended." Highlights of the survey results include:

- *The majority (68%) of respondents indicated that the opportunity to network was one of the most valuable aspects of the meeting.*
- *Participants noted that the workshop gave them ideas to try in their own classroom like exam wrappers, two-part exams, syllabus quizzes, and PhET simulations.*
- *Learning Assistants was an important topic."*

NCHEMS has provided a Year 2 evaluation report (appended) and early in Fall 2017, campus leaders will reflect on the information and identify additional improvements to the project and to network functioning. The PIs also plan to continue to use the External Evaluators as a sounding board for addressing questions, problems and new opportunities as they arise across Year 3.

In the next year, the evaluation team will continue to deeply address the evaluation questions by (a) collecting feedback following the 2017 Annual Meeting, (b) reviewing project documents and (c) collecting input from leaders and participants at partner institutions.

II. Products

Within the Products section, you can list any products resulting from your project during the specified reporting period, such as:

Conference Papers and Presentations:

Enter as Other Conference Presentation/ Paper (all should have federal funding acknowledgement)

B. Cai and A. McLean, "Design-lab Approach in a CD Diffraction Experiment", Canadian Association of Physicists Congress, Kingston, Canada, May 29-Jun 1, 2017.

- B. Cai and R. Knobel, "Applying Backward Design Strategy to Redesign Physics Undergraduate Lab Courses", Society for Teaching and Learning in Higher Education conference, Halifax, Canada, Jun 20-23, 2017.
- B. Cai, W. Thompson, and R. Knobel, "Redesign of Third-Year Physics and Engineering Physics Lab Courses", American Association of Physics Teachers Summer Conference, Cincinnati, USA, Jul 22-26, 2017.
- B. Cai, W. Thompson, and R. Knobel, "Transforming Advanced Physics Lab Courses to Include Scaffolded Projects", poster and proceedings, Physics Education Research Conference, Cincinnati, USA, Jul 26-27, 2017.
- C. Bennett & A. Greenhoot (2017, October). *The Usual Suspects? Using a Change Density Index to Explore the Impact of Multiple Change Initiatives*. International Society for the Scholarship of Teaching and Learning. Calgary, Canada.
- Mark Mort & Stephanie Chasteen (2017, November). *The TRESTLE Network: Improving STEM Education through Collaborative Course Transformation*. Association of American Colleges and Universities STEM Transformation Meeting. San Francisco, CA.
- Andrea Greenhoot, Mary Huber, Pat Hutchings, and Peter Ewell (2018- Under Review). *Transforming STEM Teaching and Learning through Department-Embedded Expertise and Community Building*. Association of American Colleges and Universities Annual Meeting. Washington, DC.
- Andrea Greenhoot, George Rehrey, Linda Slakey, Gabriela Weaver (2018- Under Review). *Multi-Institutional Networks as Catalysts for Transformative Learning and Teaching*. Association of American Colleges and Universities Annual Meeting. Washington, DC.

Enter as Journal or Juried Conference Paper (should have federal funding acknowledgement):

- T.T. Yuen, E. Bonner, W.D. Cruz, R. Roby, J. Browning, & B. Merchant, B. (2016, December). Embedded experts for undergraduate engineering faculty professional development. In *Teaching, Assessment, and Learning for Engineering (TALE), 2016 IEEE International Conference on* (pp. 389-391). IEEE. (Refereed)

Products not directly supported by NSF funds but stimulated/supported by TRESTLE- not entered under Products

- D. Salem, "Innovation in Electrical and Computer Engineering", Queen's University, ECE departmental Seminar, Canada, Kingston, Feb. 2, 2017.D.
- D. Salem, B. Frank, "The Role of Engineering Teaching and Learning Fellows in The Transformation Process of ECE Courses" Canadian Engineering Education Assembly, Toronto, Canada, June 5-7, 2017.
- Bennett, C., Collins, W., & McVey, M. (2017). A Tiered Mentoring Model for Deepening Student Learning

Across Undergraduate and Graduate Design Courses. In *Proceedings of the American Society of Engineering Education (ASEE) Conference*. (Refereed)

McVey, M., Bennett, C., Kim, J., & Self, A. (2017). Impact of Undergraduate Teaching Fellows Embedded in Key Undergraduate Engineering Courses. In *Proceedings of the American Society of Engineering Education (ASEE) Conference*. (Refereed)

Self, A., Johnson, H., McVey, M., & Bennett, C. (in press). Student Perspective of Pedagogies of Engagement. In *Proc., ASEE Midwest Section Meeting*. (Refereed)

Bennett, C., Collins, W., & McVey, M. (2017, June 28). *A Tiered Mentoring Model for Deepening Student Learning Across Undergraduate and Graduate Design Courses*. American Society of Engineering Education (ASEE) Annual Conference, Columbus, Ohio.

McVey, M., Bennett, C., Kim, J., & Self, A. (2017, June 25). *Impact of Undergraduate Teaching Fellows Embedded in Key Undergraduate Engineering Courses*. American Society of Engineering Education (ASEE) Annual Conference, Columbus, Ohio.

Websites:

<http://colorado.edu/csl/TRESTLE>

This is a public website on the CU TRESTLE project.

<http://trestlenetwork.org>

This is a public project website that is designed to enhance the TRESTLE community and disseminate our work by providing resources aligned with TRESTLE's model components, and making public TRESTLE campuses' course transformation efforts and results.

III. Participants

What individuals have worked on the project?

This information is entered separately by KU, CU and UTSA and includes all individuals who have been employed to work on the project. Information to be entered includes the following categories:

- Name
- Role- chosen from drop-down list
- Person months worked
- Email address
- Contributions

- Funding Support (funding from anything other than NSF, like the individual's home unit)
- Anyone listed will receive an email from NSF requesting they enter demographic information.

What other organizations have been involved as partners?

Also entered separately by KU, CU and UTSA, with some duplication across. Below is the info entered by KU.

Type of Organization	University Consortium
Name	Bay View Alliance
Location	Vancouver, CA
Partner's Contribution	Financial Support Other [Guidance from Hub of senior scholars. support for collaboration.]
Details on Contribution	The Bay View Alliance (BVA) is a consortium of 9 US and Canadian institutions collaborating on applied research to promote widespread adoption of effective teaching practices in higher education. The BVA fostered the university collaboration that resulted in TRESTLE project. Provided seed funding for initial network development and grant writing. Biannual meetings bring TRESTLE representatives together, and promote synergies with projects with similar aims. The central Hub of the BVA also provides guidance and informal feedback to TRESTLE investigators.

Type of Organization	NonProfit
Name	National Center for Higher Education Management Systems (NCHEMS)
Location	Boulder, CO
Partner's Contribution	Collaboration
Details on Contribution	Peter Ewell and Marianne Boeke of the National Center for Higher Education Management Systems (NCHEMS) are conducting an independent external review of the quality of the innovation, implementation, impact, and institutionalization of the collaborative research project. Methods used as part of the evaluation will include participation on the project "team" (Co-PIs, embedded STEM experts, etc.) to be kept informed, document review including being copied on internal project emails and documents, attendance at annual

	meetings, and finally collecting input from participants at partner institutions via interviews and surveys. The NCHEMS consultants will work as an integrated part of the project team, providing ongoing feedback to the PIs on the research portion of the project.
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Type of Organization	Academic Institution
Name	University of British Columbia
Location	Vancouver, CA
Partner's Contribution	Collaboration, In-Kind Support
Details on Contribution	<p>UBC is one of the seven partner universities in the TRESTLE project. By implementing its ongoing SEI and participating in our network-wide evaluation, UBC serves as a mentor and comparative institution for the other universities that are testing the TRESTLE adaptation of the embedded expert model. UBC has shared resources and lessons learned in the SEI to enhance the implementation of the adapted model at the TRESTLE institutions. Gulnur Birol and Warren Code have been the campus leaders for UBC TRESTLE participation, and have fully participated in the leaders network. Several additional faculty and staff from UBC contributed to TRESTLE activities and UBC data collection. Andrea Han, and Adriana Briseno-Garzon, along with Gulnur Birol, have coordinated implementation of the Faculty Survey at UBC), and Brett Gilley, Sarah Bean Sherman and Warren Code consulted on operations, evaluations and the COPUS</p>

Type of Organization	Academic Institution
Name	Queens University
Location	Kingston, Ontario, CA
Partner's Contribution	Collaboration, Personnel Exchange, In-Kind Support
Details on Contribution	<p>Queens University is one of the seven partner universities in the TRESTLE project. QU has implemented its adaptation of the TRESTLE model using postdoctoral teaching fellows for the first time. The University of Kansas has placed a teaching fellow in the QU physics department and the teaching fellow and faculty members have also been participating in TRESTLE network activities. QU is using their own existing resources to support on campus learning communities and to collect data to determine</p>

	<p>the impact on teaching practices and culture, as well as student learning. They are contributing those data to the pooled database for the project. Individuals from QU who worked on the project include Brian Frank and Jill Scott, who are the Principal and co-principal-investigators from QU, Natalie Simper serves as project manager, coordinating QU data collection, Klodiana Kolomitro is an educational developer who provides professional development and consultation on best practices in the project, and Rob Knobel and James Fraser are leading the course transformation program within the physics department.</p>
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Type of Organization	Academic Institution
Name	University of California, Davis
Location	Davis, CA
Partner's Contribution	Collaboration, In-Kind Support
Details on Contribution	<p>UCD is one of the seven partner universities in the TRESTLE project, supported by a subcontract under the University of Kansas. UCD is implementing an adaptation of the TRESTLE model, with their teaching stream faculty members (LPSOEs) serving as the embedded experts. Their embedded experts and faculty are participating in the TRESTLE network activities. They are examining the impact of the TRESTLE intervention model on faculty teaching practices and culture, as well as student learning, by gathering data with the common measures and contributing it to the pooled database for the project. Marco Molinaro and Stephanie Pulford are leading these efforts at UCD.</p>

Type of Organization	Academic Institution
Name	Indiana University, Bloomington
Location	Bloomington, IN
Partner's Contribution	Collaboration, In-Kind Support

Details on Contribution	IUB is one of the seven partner universities in the TRESTLE project, supported by a subcontract under the University of Kansas. IUB is implementing an adaptation of the TRESTLE model that involves developing faculty leaders within a department and connects that work to existing learning communities on campus. Their faculty are participating in the TRESTLE work activities. Like the other TRESTLE institutions they are examining the impact of this intervention model on faculty teaching practices and culture and student learning, gathering data using the common measures, and are contributing their data to the pooled database for the project. Dennis Groth and George Rehrey are leading the TRESTLE-related efforts at IUB.
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Collaborators

External Consultants

Pat Hutchings, Senior Scholar, Bay View Alliance- External consultant conducting longitudinal case studies

Mary Huber, Senior Scholar, Bay View Alliance- External consultant conducting longitudinal case studies

Marianne Boeke, National Center for Higher Education Systems Management, External Evaluator

Peter Ewell, National Center for Higher Education Systems Management, External Evaluator

Collaborators from University of British Columbia (UBC)

Gulnur Birol, University of British Columbia, UBC TRESTLE project Co-Leader

Warren Code University of British Columbia, UBC TRESTLE project Co-Leader

Collaborators from University of California, Davis (UCD)

Marco Molinaro, University of California, Davis, UCD TRESTLE Project leader (Sub Award PI)

Stephanie Pulford, University of California, Davis, UCD TRESTLE Project coordinator

Collaborators from Indiana University, Bloomington (IUB)

Dennis Groth, Indiana University, Bloomington, IUB TRESTLE Co-Investigator (Sub Award PI)

George Rehrey, Indiana University, Bloomington, IUB TRESTLE Co-Investigator

Center for Innovative Teaching and Learning. IUB- Provided personnel for training programs

Kelley School of Business, IUB- Provided personnel for training programs.

Indiana School of Informatics and Computing (Computer Science), IUB- Provided personnel for training programs

IV. Impacts

What is the impact on the development of the principal discipline(s) of the project?

The project vision is to transform the way courses are prepared to maximize student learning, retention, and graduation. The faculty in participating departments are starting to form a new method of collaboration on learning objectives and shaping course outcomes, and are utilizing evidence-based teaching practices in their courses. As indicated under Significant Results, these changes in teaching practices are beginning to yield improvements in student learning and successful course completion.

What is the impact on other disciplines?

The concepts and methods developed in this project are transferrable to other curricula, and are being communicated broadly through the cross-department communities on each campus.

What is the impact on the development of human resources?

The project is providing professional/career development to numerous individuals in STEM teaching in higher education. A major goal of the project is to enhance the professional development and education of embedded experts (postdoctoral scholars and faculty leaders) by building STEM-education communities on campus and across campuses. The multi-level learning communities are also professional development opportunities for other faculty as well as graduate teaching assistants and other instructional staff, to learn more effective ways to teach and to assess their students' learning. A strong network of student-focused teachers is created across the campuses that can support the development of multi-disciplinary approaches to new courses or educational programs. Additionally, the embedded experts and their faculty colleagues is to develop educational materials (assignments, in class activities, assessments, online modules, and overall course designs) for the courses that are being transformed, and to disseminate those to other instructors, through the intellectual communities, and later, through our project website.

What is the impact on physical resources that form infrastructure?

None.

What is the impact on institutional resources that form infrastructure?

The project creates learning communities to support individual faculty in course redesign, and to empower them to be leaders in their own disciplines to help spread the principles of student-centered learning to their colleagues. These learning communities are becoming an institutional resource on each campus. In addition, with its growing public presence, the TRESTLE network has the potential to become an organization to support department-level STEM course transformation.

What is the impact on information resources that form infrastructure?

New course designs and educational materials and lessons learned about effective processes and procedures for course transformation will become informational resources through the Teaching Centers or STEM learning centers on each campus. These resources are also being made available on the TRESTLE website.

What is the impact on technology transfer?

NA

What is the impact on society beyond science and technology?

At the end of Year 2, our impact on society is still evolving. Ultimately, we hope our findings will provide new knowledge to further our understanding of how to create scalable change on an institutional level, so that we can share the resulting insights with other institutions seeking to achieve similar changes to improve undergraduate education more generally. Moreover, the primary target of this work- improved teaching and learning in STEM courses for both STEM and non-STEM students, has immediate application to a broad societal goal. The improvements in student learning and student success that we are beginning to see in transformed courses can contribute to a more skilled and educated population with employable skills for the next century of jobs, a more diverse body of STEM professionals, and a citizenry that is informed, civically engaged, and scientifically literate.

The design of the UTSA project is intended to yield an additional broad societal impact. In particular, the K-12 teaching community is impacted through the strategic partnering of STEM curricular experts with Education pedagogical experts. Educational experts will learn more principles in STEM areas that can be translated into K-12 lessons, and how to effectively “teach” college professors to best impact student learning.

V. Changes / Problems

If not previously reported in writing to the agency through other mechanisms, provide the following additional information or state, "Nothing to Report", if applicable.

Changes in approach and reason for change:

There were some changes in approach with respect to central coordination of the project (TRESTLE Central) as well as in some of the institution-specific programs.

TRESTLE Central

- **Project Timing.** As indicated in our Year 1 report, a major change in approach was that we treated Fall 2015 largely as a planning period, which has essentially shifted the intervention timeline from a Fall-Spring project year to a Spring-Fall project year. Thus, at the beginning of Fall 2016, we are halfway through our second year of focused interventions. Corresponding changes to specific campus's approaches are detailed in the institution-specific sections below.
- **Broadening the Network.** The PI was approached by representatives of two universities in the AAU STEM Initiative that have hired teaching postdocs/embedded experts as part of their AAU projects, to ask whether their postdocs could engage with others in similar positions in the TRESTLE network. A similar request was made by Emily Miller, coordinator of the AAU initiative. The TRESTLE project leaders agreed that they would open the network to other individuals in similar “embedded expert” positions, and individuals from three campuses attended the October 2016 meeting, supported by their own institutions' funds. We are allowing for similar external participation in the

September 2017 meeting. In relation to this, Emily Miller created a discussion group for embedded experts, including those in TRESTLE, through the TRELIS platform.

- **Mid-Project Case Studies.** Pat Hutchings and Mary Huber completed the first mid-project case study in Spring 2017 and found that it required more time than they had originally anticipated. To compensate them for their additional time and allow for high quality mid-project case studies, we will use some of the funds freed up by the part-time employment of the Course Transformation Program Manager (see below) for this purpose.
- **Course Transformation Definitions and Rubric.** Discussions of our preliminary survey and COPUS data have brought to the forefront the need to agree upon a formal definition of a “Transformed Course” that can be operationalized in terms of the outcome measures we are collecting. To this end, a subset of the project team, led by the TRESTLE program manager, is collaborating on the design of a rubric for evaluating the degree and quality of course transformation. We anticipate that the project will yield an important product that could be useful well beyond the purposes of TRESTLE measurement.

Institution-Specific Changes in Approach

Some of the campuses made some additional modifications to their own programs in Year 2.

University of Colorado, Boulder

- CU decided to form an advisory board, and provide a \$500 stipend to each advisor. This provides additional oversight of the project activities and funding decisions, as well as formative feedback.
- CU decided to fund a second facilitator in the past two Scholars groups, since enrollment in the groups has expanded the intellectual partnership could help make facilitation more attractive and manageable.
- CU chose to support an emergent learning community, the Shared Innovation Discussion Group (ShInDiG), comprised mainly of individuals who participated in the SEI.
- The Expert Advisor program at CU has not been significantly used, and so is being quietly phased out of the program. The funds are being used to support the more successful Scholars groups instead.
- CU chose to host a CU-specific national meeting to help facilitation connections among participants and continued engagement.

Indiana University Bloomington

- In 2017 we changed the schedule of our two development programs. Altering it from our original timeline and proposal. The TLC was held from May 15-18th and the CDI was held from May 19- 26th.
- During Year 2 we did not recruit a CS faculty member to be the lead Fellow from cohort #1 as originally planned. We do plan to engage one faculty member from this year’s cohort to take on that role in 2018.

Queen's University

- Queen's University began and carried out its work based on the revised plans and timeline that generated during Year 1. No additional changes were needed.

University of Texas, San Antonio

- In Year 2, the COEHD faculty are working with ECE and BME engineering faculty in their course transformations. Due to the number of courses (3 in ECE and 1 in BME) and the number of faculty/teaching staff involved in this iteration (6 in ECE, 3 in BME), the Spring 2017 semester was focused on observing the ECE and BME current courses. The actual work in course redesign happened during Summer 2017 and will be implemented in the Fall 2017.
- There are three COEHD faculty members and one COEHD graduate research assistant working the engineering faculty. One serves as the coordinator of the project. Each of the other two faculty members will work with one team in particular, while the coordinator and the GRA will work across both teams.
- This year the project added another faculty member, Vittorio Marone, from the College of Education and Human Development and another department with associated faculty and course transformations.

Actual or Anticipated problems or delays and actions or plans to resolve them: (2999 remaining)

TRESTLE Central/University of Kansas

The Course Transformation Program manager (Stephanie Becker) responsible for overseeing the KU intervention and coordinating the TRESTLE project was hired in January 2016 but due to teaching commitments worked half-time until May 2016. Dr. Becker recently left the project team for a different promising opportunity (May 2017). The position was re-advertised as a postdoctoral position, and Dr. Blair Schneider was hired in April 2017. The short tenure of a full-time Course Transformation Program Manager was a major challenge for implementing the KU initiative and network-wide plans. PI Greenhoot shifted additional time to the project and hired a graduate student to take on some coordination duties. Ultimately this delayed several aspects of project implementation, including implementation of the measurement plan, by a few months, but we do not anticipate significant adverse effects on the results or ultimate impact of the project. It also freed up some funds that we are now using for other purposes.

Indiana University, Bloomington

Like QU, IUB revised its plans during project Year 1, and in Year 2 implemented those plans based on the new timeline.

University of California, Davis

A reorganization of the relevant units and infrastructure at UCD, and corresponding staffing changes, led to a shift in the personnel on this project. Specifically, a new UCD staff member, Stephanie Pulford, began to serve as the campus project coordinator and liaison (in addition to PI Molinaro) in Spring 2017. Additionally, on-campus faculty

“survey fatigue” (due to high overlap with other projects) has led to a change in faculty survey data collection approach that involves mining existing surveys for common items. The project leaders will work on this in Year 3.

University of Colorado, Boulder

It has been difficult to identify the right level of intervention and guidance for awardees of Course Transformation grants. Unlike the SEI, the PI is external to the department and thus it is challenging to know how the work is progressing and provide advice in a timely manner. In MATH, for example, the pilot course was offered twice but the PI was not informed. On the advice of the advisory board, we are meeting with all awardees at the start and end of each semester, for a discussion of how they will address issues that align with the goals of TRESTLE, such as “how will you engage the department?” The goal is for the PI to be a neutral entity while drawing attention to key issues in a way that enables departments to wrestle with these ideas, and influence one another.

The Expert Advisor service, to provide one-on-one faculty guidance, has not been popular despite repeated efforts to direct faculty to apply. This service is thus being phased out, but the directory of advisors will be maintained to be used on an as-needed basis.

Another challenge is the lack of a Teaching and Learning Center, which would be a natural home for the project. This has hampered the project’s ability to advertise and support its’ efforts with internal resources. Instead we have partnered with organizations such as ASSETT to leverage their staff, expertise, and campus reach. ASSETT conducted the COPUS observations in a new pilot program. ASSETT may also be a natural home for the Scholars communities, though they can only serve Arts and Sciences (not engineering) faculty. We plan to propose that the Course Transformation Awards be integrated with the existing Chancellor’s Awards in future years.

University of Texas, San Antonio

Dr. William dela Cruz ended his work with this project in December 2016 to join a school district.

Dr. Timothy Yuen, an Associate Professor in the College of Education and Human Development, has taken over as the Project Manager. His program area is Instructional Technology and his research examines how learning technologies support learning and engagement in computer science and engineering education. His work also examines how to increase success and broaden participation in CS and engineering at all levels. Dr. dela Cruz worked with Dr. Yuen in ensuring a successful transfer of knowledge for this project.

Dr. ReAnna S. Roby, the current graduate research assistant, has successfully defended her dissertation and will be moving on to another university. The UTSA team has identified two GRA’s to work with the increased number of assessment demands in Year 3.

Queen’s University

None to report.

External Evaluation

As planned, external evaluation activities, provided by NCHEMS, accelerated in Year 2 (AY2016-2017). We have integrated the external evaluators as deeply as possible into the project, to ensure that they can provide ongoing formative feedback on measurement and other progress. The external evaluators are included in all project communications, participate in all virtual meetings, attended the Launch Meeting in January 2016, the Annual Meeting in October 2016, and will attend the second annual meeting in September 2017.

Changes that have a significant impact on expenditures:

TRESTLE Central /University of Kansas

- The late hire of full-time Course Transformation Program Manager led to lower expenditures in Year 1 and Year 2 in that salary line. We used some of those funds to pay hourly graduate assistants to take on some coordination duties, to pay CU PI Chasteen for additional time spent coordinating the 2016 Annual Meeting, and to support slightly more labor-intensive mid-project case studies.

University of Colorado, Boulder

- PI Chasteen spent more time than expected in establishing the program, and two Scholars facilitators have been needed per community, but these expenses are being recuperated through the unused time from the Educational Advisor program.

University of Texas, San Antonio

We reorganized the pay structure to allow more compensation to the project manager, while still maintaining the impact to the department and the greater UTSA community.