



## **”It’s been a while”: Faculty reflect on their experiences implementing what they learned during an intensive summer program**

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Amy Hermundstad Nave is a Faculty Developer in the Trefny Innovative Instruction Center at the Colorado School of Mines. She earned a BS in Mechanical Engineering from Colorado State University before going on to earn her PhD in Engineering Education and MEng in Mechanical Engineering from Virginia Tech. Her research has focused on conceptual understanding in core engineering courses, opportunities to support engineering students’ professional development, and efforts to support underrepresented students in engineering. Her current work in faculty development focuses on supporting faculty members in incorporating research-based practices into their own classrooms.

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Dr. Spiegel is the Director of the Trefny Innovative Instruction Center at the Colorado School of Mines. He previously served as Chair of the Disciplinary Literacy in Science Team at the Institute for Learning (IFL) and Associate Director of Outreach and Development for the Swanson School of Engineering’s Engineering Education Research Center at the University of Pittsburgh. Prior to joining the University of Pittsburgh, he was a science educator at Biological Sciences Curriculum Study (BSCS). Dr. Spiegel also served as Director of Research & Development for a multimedia development company and as founding Director of the Center for Integrating Research & Learning (CIRL) at the National High Magnetic Field Laboratory, Florida State University. Under Dr. Spiegel’s leadership, the CIRL matured into a thriving Center recognized as one of the leading National Science Foundation Laboratories for activities to promote science, mathematics, and technology (STEM) education. While at Florida State University, Dr. Spiegel also directed an award winning teacher enhancement program for middle grades science teachers, entitled Science For Early Adolescence Teachers (Science FEAT).

His extensive background in science education includes experiences as both a middle school and high school science teacher, teaching science at elementary through graduate level, developing formative assessment instruments, teaching undergraduate and graduate courses in science and science education, working with high-risk youth in alternative education centers, working in science museums, designing and facilitating online courses, multimedia curriculum development, and leading and researching professional learning for educators. The Association for the Education of Teachers of Science (AETS) honored Dr. Spiegel for his efforts in teacher education with the Innovation in Teaching Science Teachers award (1997).

Dr. Spiegel’s current efforts focus on educational reform and in the innovation of teaching and learning resources and practices.

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Abstract

This research paper describes the study of 32 faculty members who participated in a Summer Intensive Course Revision (SICR) program. The SICR was a month-long learning and working session that included face-to-face instruction, reading, and time to work alongside pedagogy and curriculum experts to design or revise a targeted course. The SICR utilized an Engineering Learning (EL) framework that guided faculty through an intentional course design process. The EL framework shifts faculty from focusing on the delivery of content to the role of designer and facilitator of learning. The SICR took place during the summers of 2016, 2017, and 2018. In this study, we examined the elements from the SICR that faculty continue to use in their courses after participating in the program. This is an important and fundamental study to consider as the long-term influences of educational development initiatives are rarely studied systematically years after their initial contact. In addition, changes in teaching practice are frequently not evident immediately after participating in professional development; often instructors need time to implement and incorporate what they have learned into their teaching practice.

The purpose of our study is to explore the lasting impact of the SICR on faculty participants. In particular, this study focused on three research questions: 1) What elements from the SICR do faculty describe as practices that they continue to use in the design and implementation of their courses more than two years after participation?, 2) What do faculty describe as challenges in implementing their redesigned courses since participating in the SICR?, and 3) What do faculty describe as positive outcomes of participating in the SICR or implementing their redesigned course? We interviewed 32 faculty who had participated in the SICR in 2016 and 2017, using a semi-structured set of interview questions. In order to adequately capture sustained change over time, faculty from only the first two cohorts, summers 2016 and 2017, were interviewed, allowing for at least two academic years to have passed. Interviews were coded and analyzed using a six phase thematic analysis approach. Ten themes and 19 codes were identified fitting into the 5 phases of the EL Framework. Results indicated that learning outcomes were extremely important to participants, successes and challenges spanned 4 phases of the EL framework, and faculty were striving for continuous improvement. Implications of the study include the identification of practices that faculty perceive as relevant and continue to use even years after participating in faculty development programming. These results can help educational developers design programming that can have a lasting impact on faculty and their teaching practice.

Our preferred presentation method for this paper is a traditional lecture.

## Introduction

Teaching and learning centers are becoming more ubiquitous on university campuses filling a vital need to help facilitate teaching professional development for faculty. These teaching and learning centers offer workshops, trainings, one on one consultations, and support to faculty at universities. However, there is often little empirical evidence to support the relative impact of professional development programs on teaching practice [1]. While there has been a growing body of work on the programming by some teaching and learning centers, it tends to focus on evaluation based on data gathered at the conclusion of the program, such as centers administering participant satisfaction surveys [2, 3]. This does not necessarily help centers evaluate whether or not the program succeeded in meeting their intended objectives. Studying effectiveness of professional development programs is necessary to understanding why some educational reforms and initiatives succeed or fail [4].

## Current Study

The current study aims to help fill this gap and identify the practices that participants continue to implement years after participating in programming facilitated by a center for teaching and learning. This study takes place at Colorado School of Mines, a medium-sized public engineering university in the southwest. During the summers of 2016, 2017, and 2018 faculty applied for and participated in a month-long course lead by the university's teaching center, the Trefny Innovative Instruction Center. The course was called the Summer Intensive Course Revision (SICR) program. The purpose of the program was to provide focused time for a cohort of faculty to learn new pedagogy and course design theory, work both collaboratively and independently as they focused on enhancing their teaching, and significantly revise a course that would be taught by the faculty member during the following academic year.

Faculty were provided one month of salary support to participate in this intensive learning and working program. The SICR included classes, readings, and time to work alongside pedagogy and curriculum experts as faculty designed or revised a targeted course. The overall goals of the program were to: 1) design or significantly revise a course of study utilizing sound pedagogical practices, 2) create a student-centered syllabus and course map for the revised course, 3) design rigorous learning experiences for the targeted course that actively engaged students to achieve or exceed the course learning outcomes, 4) develop reflective practitioner skills to enact continuous improvement through the regular collection and analysis of data, and 5) connect with colleagues to form a supportive learning community and cohort. See [5] for a more detailed description of the SICR program and the Trefny Innovative Instruction Center.

The design or significant revision of the course was guided by the Engineering Learning (EL) framework (described in more detail below) [6]. This framework included aspects involved in the course design process such as: the clear articulation of learning outcomes, the design of rich assessments – both formative and summative –aligned to the learning outcomes, developing support for diverse learners, and refining course instructional sequence and design to increase coherence in the learning progression and content. In addition, the EL framework is the conceptual framework we will be utilizing to frame this research study.

## Engineering Learning Framework

Engineering Learning is a framework that guides faculty through an intentional course design process. One key purpose of the EL framework is to shift faculty from focusing on simply covering content to the role of designer and facilitator of learning or a “learning engineer” [7]. The EL design process is based on a backwards design approach [8] and connects to research-based teaching approaches that allow faculty to thoughtfully design a course. There are five phases and corresponding questions to guide faculty through the EL framework:

1. **Articulate:** What is the intended purpose and overall description of the course?
2. **Design:** How can I design the course to ensure that the learning outcomes, instructional activities, and assessments are aligned and are meeting the needs of the university’s students?
3. **Enact:** Am I teaching the course as intended using effective teaching strategies that are supporting all my students?
4. **Reflect:** What should I pause and consider after the course is completed to help in my teaching and in this course design?
5. **Collaborate:** How can I collaborate with others to improve my own teaching as well as influence teaching and learning at the university?

The use of the EL framework to engage in course design changes the conversation of covering content to one more focused on student learning. Engineering Learning can require significant shifts in how the faculty approach teaching and learning in higher education. The intention in using this framework is to realign instruction with 1) current research-based approaches to teaching and learning, 2) changing student needs, 3) student passions and interests, and 4) the practices and understandings desired by industry and needed for the future of engineering. See Figure 1 for an illustration of the EL framework.

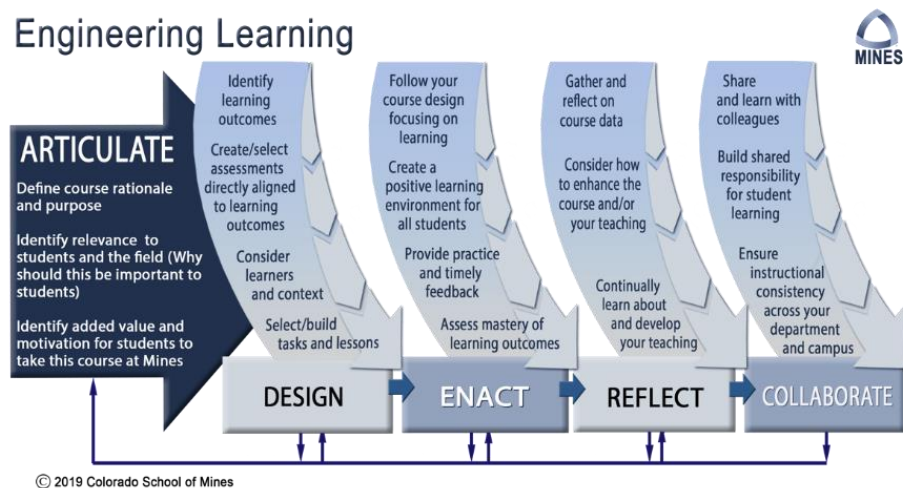


Figure 1. Engineering Learning Framework

### Purpose of the Study

The purpose of our study is to explore the lasting impact of the SICR on faculty participants. In particular, this study focused on three research questions: 1) What elements from the SICR do faculty describe as practices that they continue to use in the design and implementation of their courses more than two years after participation?, 2) What do faculty describe as challenges in implementing their redesigned courses since participating in the SICR?, and 3) What do faculty

describe as positive outcomes of participating in the SICR or implementing their redesigned course? In order to adequately capture sustained change over time, faculty from only the first two cohorts, summers 2016 and 2017, were interviewed, allowing for at least two academic years to have passed since participation.

## Method

### Participants

Forty-eight faculty participated in the first two SICR programs. All faculty were contacted and invited to participate in the interviews. Four faculty were no longer at the institution, one faculty member declined to participate, and nine faculty members did not respond. Thirty-four faculty agreed to be interviewed, though two faculty did not agree to sign the consent forms. Therefore, the final sample consisted of 32 faculty members. Fourteen of the faculty were women and 18 were men.

There was a good mix of different levels of faculty participants, at the time of the interview there were two faculty as department or division heads, two as professors, three as assistant professors, six as associate professors, nine as teaching professors, and ten as teaching associate professors. In addition, 12 of 17 academic departments were represented. The departments represented include Applied Mathematics and Statistics (n=6), Chemistry (n=4), Engineering, Design, and Society (n=4), Chemical and Biological Engineering (n=3), Humanities, Arts, and Social Sciences (n=3), Mechanical Engineering (n=3), Physics (n=3), Geology and Geological Engineering (n=2), Civil and Environmental Engineering (n=1), Economics and Business (n=1), Mining Engineering (n=1), and Petroleum Engineering (n=1).

### Procedure

Faculty were contacted via email to arrange the interview. At the beginning of the interview, faculty received both a consent form and an audio recording consent and release form to sign. Interviews typically lasted less than 30 minutes, with interview times ranging from 8 to 30 minutes depending on how talkative the faculty member was. Open-ended semi-structured format questions were used flexibly, being omitted, adapted, or elaborated according to the demands of the individual context (see appendix for list of interview questions). All interviews were audio recorded and transcribed.

### Analysis

Responses were analyzed using the thematic analysis procedure described by Braun and Clarke [9, 10]. Braun and Clarke utilize six phases of thematic analysis [9, 10]. The six phases are a recursive guideline to follow and include; 1) familiarizing yourself with your data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) producing the report. This process involves a constant moving back and forth between the entire data set, the coded extracts of the data, and the analysis of the data that is being produced. In addition, we were guided by the realist method [9], meaning we were specifically interested in the faculty's own accounts of their experiences and points of view.

Following transcription, two of the authors read and re-read the interviews to become familiar with the data. During this familiarization phase, notes were made marking potential codes and guiding the development of the initial codes around each of the three research questions.

Following the development of the initial codes, the two authors independently coded the interviews utilizing the initial codes. For each research question, there was also a miscellaneous code in order to capture other elements, challenges, and positive outcomes that might not be captured with the initial codes. The two authors then met to discuss the initial codes and segments that were coded with the miscellaneous codes. In discussing the miscellaneous segments, additional codes for each of the three research questions were identified. In addition, we discussed possible overlap of codes and condensed overlapping codes. Given that our conceptual framework, described above, is guiding this research, we mapped the codes on to the 5 phases of the EL framework and codes were grouped into themes resulting in 10 themes with 19 codes. Interviews were then recoded using the updated codes. This was a top-down or theoretical analysis, rather than an inductive one.

Intercoder agreement was checked using two methods as described by Guest, MacQueen, and Namey [11], subjective assessment and percent agreement. Both methods were used on a random subset of five interviews. Two authors met to discuss five of the interviews, reviewing the codes section by section and discussing any disagreements before reaching a consensus on the code and segment. In addition, a percent agreement was calculated for the five interviews by dividing the total number of times coding is in agreement by the total number of code comparisons, resulting in 83% agreement. As a note, 80% agreement is considered good agreement [11].

## Results

The results will be discussed in relation to the three research questions: 1) What elements from the SICR do faculty describe as practices that they continue to use in the design and implementation of their courses more than two years after participation?, 2) What do faculty describe as challenges in implementing their redesigned courses since participating in the SICR?, and 3) What do faculty describe as positive outcomes of participating in the SICR or implementing their redesigned course?

### Research Question 1: Practices from the SICR

Two themes were salient among participants' descriptions of practices that they continue to use in their classes following the SICR (see Table 1).

Table 1. Themes for research question 1

<b>Theme</b>	<b>Theme Definition</b>
The importance of learning outcomes	Developing and using learning outcomes to guide the design of the course and to guide instruction (backwards design).
Create learning opportunities	Creating learning opportunities for students and assessing student learning.

Within these two themes, there are five codes. Each will be described briefly below and you can find codes, code definitions, and code examples in Table 2.

Participants described the importance of learning outcomes and discussed defining clear learning outcomes, aligning course components (e.g., aligning assessments with the learning outcomes so the assessments are direct measures of the learning outcomes), and communicating learning outcomes to students to guide learning. Clear, measurable, and explicit learning outcomes were

described as necessary because all other components of the course need to align with and help students achieve those learning outcomes. In addition, participants described the importance in sharing the learning outcomes with students and continuing to refer back to them throughout a course. This communication was particularly important given that students are novices and may not see connections between topics without guidance from an expert, the instructor. The learning outcomes helped make explicit what is expected from the students and provides the targets for designing and enacting the learning experiences.

The second theme focused on creating learning opportunities and included incorporating student-centered instruction such as active learning and assessing student learning. Participants stated that they continue to think about ways to incorporate active learning and the SICR provided specific strategies, such as minute papers and think-pair-share, that faculty could incorporate. In addition, formatively assessing student learning across a course to allow both the instructor and the student to gauge student progress was another practice faculty frequently mentioned.

Table 2. Codes for research question 1

Theme	Code	Code Definition	Code Example
The importance of learning outcomes	Define learning outcomes	Participant describes the need for or creation of learning outcomes	<i>I think the first really valuable lesson was how to draft student learning outcomes. That was really the first part, I think we focused two weeks, the first two weeks of the program just to draft, really carefully just to choose the right words to map to the right learning outcome. (P1918)</i>
	Align course components	Participant describes aligning assessments, activities, and/or learning outcomes. This includes creating/designing components that are aligned.	<i>Specifically, [starting with] course outcomes and then thinking about assessment and then some of the exercises and activities that can be done. [...] So there is that process [of] engineering learning. (P1927)</i>
	Communicate or use learning outcomes to guide student learning	Participant describes communicating learning outcomes and/or connections between course concepts to students during the course (includes using learning outcomes during the class to help students know where they are in the course).	<i>So it is important to have those [learning outcomes] to keep you focused on what it is you are covering, keep the students in the loop why you are talking about this today when you talked about these seemingly other thing, even though we know what the connections are, the students might not know that. Hopefully the learning objectives make it more transparent for everyone else involved. (P1901)</i>
Create learning opportunities	Incorporate student-centered instruction	Participant describes incorporating activities in their course that actively engage students in the learning process through practice, interaction, feedback, and/or reflection. This includes instances where participants describe using active learning generally and/or using specific techniques and activities (such as think-pair-share, group work, polls).	<i>I'd say, on the more day to day basis, [the SICR element I still actively use is] just more active learning. So I used to, larger classes used to primarily be lecture driven, now there is not a single class that doesn't involve some sort of activity or back and forth. Some classes are still so large there has to be some lecturing. But really on the day to day basis the class interactions has changed. (P1932)</i>



<b>Theme</b>	<b>Code</b>	<b>Code Definition</b>	<b>Code Example</b>
Create learning opportunities	Assess student learning	Participant describes incorporating assessments (either formative or summative) to allow either the instructor or the student to gain insight into student learning and progress. This does not include instances where the participant discusses the creation or design of rubrics.	<i>A lot of the assessment techniques that are short easy things to do, like asking them to reflect on something, and write about that or even say something about it. I taught an online class this summer and as part of that I had students record themselves explaining a solution to the problem. And so that seemed to be a really good learning tool for them with the metacognition piece of it. So I also now implement that in my face to face class. So when they turn in their homework assignment they also turn in a short little video explaining one of the problems. (P1920)</i>

### Research Question 2: Challenges implementing the redesigned course

Our second research question explored the challenges that faculty encountered when implementing their redesigned course as shown in Table 3.

Table 3. Themes for research question 2

<b>Theme</b>	<b>Definition</b>
Decisions around content depth or breadth	Challenges determining what and/or how much content to include in the course.
External constraints	Challenges due to limited resources and logistics.
Winning over others	Challenges associated with the perceptions of and working with others.

Within these themes, there are five codes. Each will be described briefly below and you can find codes, code definitions, and code examples in Table 4.

One challenge that participants described was determining how much content to tackle in their redesigned course and to what depth. While described as a challenge, participants stated that clearly defined learning outcomes were useful to refer to when making decisions about content.

Another set of challenges were related to external constraints, such as lack of time and resources and logistical challenges. While participants appreciated that the SICR was a dedicated space to redesign their course, they expressed a desire to have more time during the SICR to design their course, as opposed to learning about the theory behind SICR concepts (e.g., active learning). In addition, participants struggled to find the time to incorporate student-centered instruction in a meaningful way after the SICR experience concluded due to other external demands on their time, such as committee work, office hours, research, and other classes they taught. One logistical challenge that instructors commented on were large class sizes leading to challenges implementing active learning techniques. These logistical challenges presented a barrier to instructors, making them feel that it was difficult to implement ideas from the SICR.

Winning over others through collaboration and buy-in were additional challenges. While not all faculty expressed challenges with resistance or lack of buy-in from others, some participants described resistance from students, other faculty, and others in their department. For example, participants recounted comments from students and other faculty members that they were “not teaching” because they were not delivering content (lecturing). In some instances, these perceptions decreased as the semester progressed or as more faculty on campus incorporated active approaches to teaching. Participants also expressed challenges when teaching a course that was co-taught with others. The co-teaching environment led to challenges because individual faculty members did not have complete control over the course and how or what is taught and because they wanted consistency between sections and other co-instructors (who had not participated in the SICR) who often did not want to modify their own teaching approaches.

Table 4. Codes for research question 2

<b>Theme</b>	<b>Code</b>	<b>Code Definition</b>	<b>Code Example</b>
Decisions around content depth or breadth	Content coverage	Participant describes challenges determining what and/or how much content to tackle/include in the course.	<i>The other thing I have thought about a lot, and struggled with, is deciding which, thinking about which content is critical and which content is nice to know. Trying to eliminate content that isn't critical. So that is something I have continued to kind of think about. The course I did has way too much content, they are not going to see it somewhere else. So I feel stuck on this one, for this particular course. So that is something I have struggled with. But I am still trying to figure it out. (P1929)</i>
External constraints	Time and resources	Participant describes a lack of time/resources and/or wanting more time/resources to design/redesign a course. Resources can include financial, personnel, etc.	<i>The second one, being time. I am sure you hear this from everyone, especially those of us who are teaching faculty. There is this expectation that you are doing constant revisions and so on. But it is hard, it is just really hard, the kind of forward march of the semester and so on. (P1910)</i>
	Logistics	Participant describes logistical challenges with large class sizes and/or with physical classroom space.	<i>And this course that I am teaching it consistently has over 500 students in it every semester. And now with the increased enrollment we are going to hit over 600 students starting this spring. And so, yeah, so that is just a huge, that is, you asked earlier about challenges, that's a huge challenge how to help every single student in that class engage effectively is really hard. (P1902)</i>
Winning over others	Collaboration	Participant describes challenges collaborating with other faculty on the same course.	<i>Some of the challenges are [that I] teach multiple sections. [I] need to make sure I have buy-in from all the faculty. But I don't teach every time, another teacher might teach the class next semester. So I don't want to get too far afield because we want continuity between the professors that teach the class. So that is one challenge. Some [faculty] are more open to trying things than others [are]. (P1914)</i>
Winning over others	Lack of buy-in	Participant describes lack of buy in from department, colleagues, students, and/or others on campus.	<i>My department head is generally on the surface supportive, but he also made comments along the lines of he doesn't think what I am doing anymore is teaching. [...] Like, he went to one of my proof classes. [He said,] "That isn't really teaching, you are doing recitations," or something like that. "Students are doing work and you are kind of walking around and talking to them." (P1913)</i>

Research question 3: Positive outcomes of participating or implementing the redesigned course

Our third research question examined the successes that faculty perceived in implementing their redesigned course, as outlined in Table 5.

Table 5. Themes for research question 3

<b>Theme</b>	<b>Definition</b>
Cross pollination of ideas	Benefits in learning from/with others and incorporating ideas in a range of courses.
Instructor positive affect	Positive emotions that the instructor feels when implementing the redesigned course.
Student positive affect	Positive emotions that the instructor reports/perceives that students feel when taking the redesigned course.
Student learning	Increase in perceived or actual student learning (general, conceptual, specific skills).

Within these themes, there are nine codes. Each will be described briefly below and you can find codes, code definitions, and code examples in Table 6.

One positive outcome that the SICR participants described was the cross pollination of ideas including the ability to learn from colleagues who taught different courses and to use ideas from the summer intensive in other classes. The SICR, which was open to faculty across all departments, provided an opportunity for faculty, who might not otherwise interact, to come together and learn. And participants stated that they used ideas from the SICR not only in their redesigned course, but also in other courses that they taught. This cross pollination of ideas was described as a very successful part of the SICR.

In addition, participants described benefits for themselves as instructors. Several faculty members stated that the SICR helped them become more confident in implementing student-centered instruction. Faculty members felt that their teaching abilities had improved following the SICR and they were more comfortable engaging students in the learning process during class. Faculty also mentioned that they enjoyed teaching more following the SICR.

Participants reported several benefits for students including increased student enjoyment of the redesigned courses and increased student engagement. Whereas some participants expressed that students resisted active learning at times (see challenges above), other participants stated that students appreciated and enjoyed more engaged learning environments. This increased engagement described by faculty included more perceived student interaction with peers and/or faculty. In addition to faculty perceptions that students were more engaged and enjoying the course more, some faculty reported that student end-of-course evaluations for the redesigned course were higher.

The final success that faculty described in implementing their redesigned course was a perceived or actual (where participants had comparable data to document the changes) increase in student learning and skill development. Faculty stated that students better understood course concepts,

developed transferrable and useful skills, were able to solve more difficult problems, and performed better in the course overall.

Table 6. Codes for research question 3

Theme	Code	Code Definition	Code Example
Cross pollination of ideas	Ideas spilling over	Participant describes using ideas from the SICR in other courses beyond the course that they redesigned during the SICR.	<i>You can't help but use [in-class active learning techniques]; if you are using them in one class, I totally see how I can use that same approach but apply it in another class. So 100% yes to little changes, but no big redesign. (P1911)</i>
	Opportunities to collaborate	Participant describes the benefit in working with others (either in the same department or in a different department) when designing or implementing their course.	<i>I was thrilled to be in an environment, with colleagues from across the campus, some who, I still consider them to be the rock stars. They were here learning and I was like, wow, I am here learning. So you know I learned from them. I still have the greatest appreciation for that experience. I think that really, really helped me develop as an instructor. (P1922)</i>
Instructor positive affect	Enjoyment	Participant describes more enjoyment teaching their redesigned course.	<i>I do think it is more fun. Personally, I have enjoyed it more. Interacting with the students more, rather than just watch me do some math and then watch me do some more math. And then don't talk to me ever. This is something I actually get to talk to them a whole lot more regularly. I think it is more fun. (P1909)</i>
	Confidence	Participant describes more confidence in teaching after implementing their redesigned course.	<i>At the very least I am more confident of myself, knowing myself, knowing my role in what I can offer for the students. I think that is legitimately, a) what makes me want to be better and b) that the students can see I want to be a better educator, that is an important thing to note. (P1907)</i>
Student positive affect	Student engagement	Participant describes more and/or continued student engagement with peers, instructor, and/or course content.	<i>I feel like thinking back to when I taught the class before I made some changes to now. There is a lot more interaction in the class, not only between myself and students, but student to student interactions. So, yeah, on the grand scale I feel like that has been a success. (P1911)</i>
Student positive affect	Student enjoyment	Participant describes perceptions of and/or evidence of (e.g. from evaluations) students enjoying and/or liking the redesigned course and/or components of the course.	<i>Students really appreciate the hands on activities now. I think the morale of the course has gone up. (P1926)</i>
	Student evaluations	Participant describes receiving good/improved evaluations (numeric rating and/or positive comments from students) for the redesigned course.	<i>I actually was really shocked to see the student evaluations, for us it is a large class, about 60 students. The number of students who participated in the evaluation was a really high percentage and I think my rating was a 4.9 or something and I was just shocked, that they, I think a lot of that had to do with the class, more than me, that it was about, they had a really good experience. (P1927)</i>

Theme	Code	Code Definition	Code Example
Student learning	Skill development	Participant describes the importance of helping students develop useful and/or specific skills.	<i>I have had people tell me, I think I am going to use this. I feel confident, that I can put this on my resume, that I can use the software. I will use this later on. (P1926)</i>
	Student success in general	Participant states that students were more successful in the course (e.g., as evidenced by grades, DFW rates, etc.), at achieving the learning outcomes, and/or understanding course concepts.	<i>It was super successful in my opinion in terms of their learning outcomes. The first time we did it there was a significant gain in their abilities to recognize, identify properties and then solve a problem that was actually, focused more on higher order learning than the original version. They went from a 69 average to an 82 average. (P1920)</i>

A final theme, continuous improvement, spanned all three research questions. Continuous improvement, the idea of continually refining and making modifications to a course, was described as a practice from the SICR that faculty continued to use. Faculty discussed using course assessments and feedback from students to continue to refine their course overall as well as specific elements in their course.

When describing continuous improvement as a challenge, participants described frustrations when implementing changes and not seeing the outcomes that they expected would result from those changes. Some participants did not see measurable increases in student learning, one participant stated that it was difficult to measure the effects of changes made when several aspects were changed, and one participant aimed to use practices from the SICR to reduce the gender gap but did not see measurable progress towards that goal.

When describing continuous improvement as a success, participants described success in collecting data and sharing their redesigned course with peers at the same institution or through the dissemination of scholarly work. Being able to examine their course in more detail and write papers that helped build a research portfolio was a benefit for participants.

## Discussion

Faculty who participated in the SICR incorporated a range of practices in their courses two or more years after participating in the program. In essence, the SICR shifted the way faculty think about, approach, and discuss (changed the conversations) teaching and learning (courses). The uptake and resilience of the changes in practices can be attributed to several design factors incorporated into the SICR, which we discuss below. In implementing changes to their course, faculty described a range of challenges and described a variety of successes. These practices, successes, and challenges align with the five phases of the Engineering Learning framework (Figure 2).

	RQ1: Practices	RQ2: Challenges	RQ3: Successes
Articulate			
Design	The importance of learning outcomes	Decisions around content depth	Cross pollination of ideas
Enact	Create learning opportunities	External constraints	Instructor positive affect
			Student positive affect
			Student learning
Reflect	Continuous improvement		
Collaborate		Winning over others	Cross pollination of ideas

Figure 2. Themes aligned with the EL framework

The EL framework helped support the faculty uptake and persistence of the learned practices in several ways. First, the EL framework was designed to orient engineering faculty to research-based curricula design and enactment. We did this by using an engineering design model and engineering language (as appropriate) to create a familiar framework for the faculty. Further, having a formalized framework that can be referenced across all of our professional development effort builds consistency in messaging as well as reinforcement of the practices over time.

Secondly, the EL framework provided a common vocabulary and lens to reduce the gaps and support substantive discussions around teaching and learning. The first week of the SICR focused on developing common understandings of the terminology so that we formed efficient convergent teams of faculty focused on revising and enhancing courses. It is worth noting that in our instance, the course revisions were not done to address deficits or large learning gaps. As an engineering institution, all of our students are high performing coming in with average SAT Critical Reading and Math score of 1380 and above. We also have a 92% retention rate for first-year students and a graduation rate above 80%. Therefore our faculty are focused on course revisions as enhancements not fixes.

Lastly, while participants described both challenges, such as limited time and resources, and successes, such as enjoyment and positive student outcomes, in implementing their redesigned course, faculty described their course revisions as an iterative, ongoing, and continuous process. This indicates that faculty were continuing to engage with the concepts from the SICR and working to incorporate these concepts into their regular teaching roles and responsibilities. While the entire course redesign process was time consuming (a challenge), participants described the ability to incorporate several individual concepts, such as active learning strategies, into their redesigned courses and into other courses that they taught, even if they had not fully redesigned these other courses. This spread of ideas into faculty member's day-to-day teaching responsibilities emphasizes the importance of helping faculty make small changes, which can lead to larger changes, in programs such as the SICR. We intentionally structured and communicated the EL framework as a core aspect of our work to help faculty identify the various components involved in course design and further reinforce the up-take of specific aspects of the course design process. This notion of 1) using the EL Framework to identify a variety of aspects

involved in course design and 2) beginning with small changes is helping shape our future work, as discussed below.

### Implications

We were able to study the effects of a program years after the program took place, and faculty are still reporting they are using what they learned and furthermore are enjoying teaching their redesigned course. The faculty's self-reports are consistent with observation data and student feedback [5, 6, 12]. In addition, using the EL framework to design the SICR and also to frame this research shows that a framework can be especially helpful in the process of designing, implementing, and assessing faculty professional development. We are proud to note that the overall goals of the program were met and sustained over time, something not frequently reported [1].

The cohort model also facilitated the cross-departmental work noted above. Additionally, the cohorts became supports for each other and aided in the spread of the work to other faculty who did not participate in the SICR [13].

Our assessment of the program also showed us that several components of the EL framework, such as; articulation, reflection, and collaboration, could use further support in faculty development programs and instruction. Participants talked about these phases the least and we had the least amount of codes in these phases. Future work can focus on helping support faculty in these phases of the EL framework.

### Considerations and Limitations

We understand this was a unique program with substantial institutional support that might be hard to replicate at other teaching and learning centers. Having the financial resources to pay faculty to participate in a month-long development program might be difficult. We were able to argue for the funds from our Board of Trustees to jump start what was a new initiative in order to focus on enhancing learning and teaching on campus. Part of our argument was that forming cohorts and having them work through intensive learning and course redesign would build capacity and help meet two program goals: 1) significantly change the way faculty approach courses, moving towards more student-centered learning and intentional instruction driven by measurable learning outcomes, and 2) marking to campus that leadership supports and endorses innovations in teaching.

### Future Work

We will be taking what we have learned from this assessment and applying it to our programs moving forward. We are currently working on transforming this month-long SICR into a week long summer event, followed by workshops spread throughout the academic year. The idea is to teach faculty the same course revision strategies learned in the month-long course in a more sustainable model, giving faculty more flexibility in when they focus on different aspects. Future publications will examine the effectiveness of that updated and condensed workshop structure.

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## Appendix

### Interview Questions

- Thinking back to the Course Redesign Workshop, what things that you learned have stuck with you the most? What elements are you still actively using in the courses you teach?
- Are you still teaching your redesigned course? If they answers yes: Are you continuing to refine it? If they answer no: Did you revert back to the old course design or are you just no longer teaching that course?
- Have you redesigned any additional courses? Has your learning and redesign spilled over to additional courses? In what ways?
- What has been the biggest challenges/barriers related to continuing to implement your redesign work?
- What has been some of the biggest successes related to implementing your redesign work? What has helped facilitate those successes?
- Do you have evidence that students are more engaged and/or learning more as a result of your work in the Course Redesign Workshop?
- Which knowledge/skills/ideas/concepts acquired during the Course Redesign Workshop have you not implemented? Or maybe you implemented them, but no longer implement them? Are you planning on implementing them in the future?
- What do you think we should know about your experience with this Course Redesign Workshop and the impact it has had on your teaching that I haven't asked you about?
- How did your view of teaching or what a teacher is change from what you learned during the workshop? Do you still believe what you learned about teaching and what it is to be a teacher?
- Have you met with any resistance from other faculty, your department, or students when implementing your redesign work? If they say yes, unpack what the resistance is and how they dealt with it.
- Tell me about your professional social network. To whom do you talk about teaching?
- Have you had an opportunity to collaborate with other faculty or staff around teaching professional development?
- Since the Course Redesign Workshop what additional training/workshops/professional development have you been engaging in to enhance your teaching? Both inside/outside of Mines.
- Is there any teaching professional development you would be interesting in seeing the Trefny Center offer?