Developing a Summer Engineering Teaching Institute for Community College Engineering Faculty

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Abstract

The California Community College system plays an important role in providing affordable and accessible education to diverse student populations by allowing them to complete all of their lower-division course work and then transfer to a four-year institution to complete a bachelor's degree. However, the increasing divergence of the lower-division requirements among different four-year institutions and among the different fields of engineering, coupled with decreasing enrollments and resources, has forced many community colleges to cancel low-enrollment classes and high-cost programs including those in engineering.

To address this issue, four community colleges in the San Francisco Bay Area developed an innovative program titled Creating Alternative Learning Strategies for Transfer Engineering Programs (CALSTEP). Funded by the National Science Foundation through the Improving Undergraduate STEM Education (IUSE) program, CALSTEP aims to enable small-to-medium community college engineering programs to support a comprehensive set of lower-division engineering courses that are delivered either completely online, or with limited face-to-face interactions. In addition to developing and implementing curriculum materials and resources for the core lower-division engineering courses, one of the main components of CALSTEP is disseminating the curriculum widely in California community college engineering programs. This is done through the Summer Engineering Teaching Institute, which is a two-day teaching workshop that introduces community college engineering faculty to the CALSTEP curriculum, and assists faculty in implementing the curriculum and developing alternative teaching and learning strategies to increase enrollment and improve teaching effectiveness. Results of curriculum development and the implementation of the Summer Engineering Teaching Institute will be highlighted in this paper, as well as future plans to maximize the impact of the program in increasing access to engineering education among thousands of community college engineering students and strengthening engineering transfer programs in the state.

1. Introduction

Addressing the retention problem in the first two years of college is one of the effective and efficient strategies in meeting future demands for engineering professionals to retain the nation's historical preeminence in science and technology [1]. The California Community College System, with its 114 campuses enrolling approximately over two million students—representing over 25 percent of the nation's community college student population—is in a prime position to grow the future STEM workforce [2]. However, with shrinking resources and the increasing cost of education, an effective approach is to "more fully exploit the advanced information technology capabilities that science and engineering have produced, which have proven to be valuable in reducing costs and improving productivity in manufacturing and private sector businesses" [3].

In 2014, four colleges in Northern California, Cañada College, College of Marin, Monterey Peninsula College, and Skyline College collaborated to develop the Creating Alternative Learning Strategies for Transfer Engineering Programs (CALSTEP) in order to help strengthen California community college engineering transfer programs. CALSTEP is a three-year project funded by the National Science Foundation through the Improving Undergraduate STEM Education (IUSE) Program, and one of its main objectives is to develop laboratory courses that are delivered either completely online, or with limited face-to-face interaction. The online laboratory courses developed include *Introduction to Engineering* [4], *Engineering Graphics* [5], *Materials Science* [6], and *Circuits* [7]. Each of the four partner institutions is responsible for developing curriculum for a specific course, and the curriculum materials developed are shared, piloted and tested at the four sites. Together with the online lecture courses previously developed by the CALSTEP team, these lab courses will provide community college engineering students with access to the full range of lower-division engineering courses needed for transfer to a four-year institution.

A major component of CALSTEP project is disseminating the curriculum widely in California community college engineering programs. This is done through the Summer Engineering Teaching Institute, which is a two-day teaching workshop that introduces community college engineering faculty to the CALSTEP curriculum, and assists faculty in implementing the curriculum and developing alternative teaching and learning strategies to increase enrollment and improve teaching effectiveness. This paper focuses on the results of CALSTEP curriculum development and the implementation of the Summer Engineering Teaching Institute, as well as future plans to maximize the impact of the program in increasing access to engineering education among thousands of community college engineering students and strengthening engineering transfer programs in the state.

2. Developing the CALSTEP Curriculum

Four core lower-division engineering courses were the focus of the CALSTEP curriculum development: *Introduction to Engineering*, *Engineering Graphics*, *Materials Science*, and *Circuits Lab*. In developing the CALSTEP online laboratory courses, consideration was given to the thirteen objectives for engineering educational laboratories defined by the ABET/Sloan Foundation effort [8][9]. CALSTEP curriculum development also employs evidence-based approaches that maximize persistence and learning in a distance environment, including the use of inquiry and design-oriented activities that engage students in authentic engineering experiences. Content is delivered using a variety of formats similar to those used in many existing online and hybrid engineering courses [10-16].

Introduction to Engineering

The *Introduction to Engineering* course is an ideal forum to create opportunities for a rich, engaging, and empowering experience for students to both get oriented to engineering disciplines, job functions, and overall career awareness, as well as to help students develop the growth mindset and success strategies needed to be a successful college student in a rigorous technical field. As such, many of the activities developed for the lecture and laboratory Introduction to Engineering curriculum are designed to help students grow in these vital areas.

In developing the lab experience for this course, a primary objective was to identify and design a set of experiments that provided hands-on exploration in the major fields of engineering and the engineering design process, which could also work well in a remote learning setting. A related objective was to identify a set of equipment to support these experiments with minimal travel to a college campus, without compromising the caliber of technical skill typically gained in a lab with a comprehensive set of equipment. In addition to exposure and exploration in the major engineering disciplines, emphasis was placed on fostering general experimentation skills such as how to design an experiment; familiarity with lab instrumentation; how to properly plot, analyze, and interpret data; how to assess and quantify measurement error; and how to report results with honesty and integrity.

In terms of the lab activities, the course begins with labs designed to teach students skills in experimentation, measurements, and error analysis, along with techniques in a spreadsheet program and MATLAB/FreeMat for data visualization, analysis, and interpretation. The course then progresses to explore topics in Materials Science, and Civil and Mechanical Engineering. Midway through the semester, a bridge competition is held and the students work on a Student Educational Plan that projects their coursework all the way through graduating with the Bachelors of Science degree. Finally, the course finishes up in Electrical and Computer Engineering with topics in electronics and test equipment, sensors and measuring physical phenomena, microcontroller programming and data acquisition, and select topics in robotics with a design competition.

Two design project competitions are integrated into the curriculum, with experiments built into the schedule for students to build the required skillsets and work on their designs leading toward the competition. The design projects are intended to provide an experience for students to gain confidence and ability in teamwork, communication, scheduling, and leadership. The first project is a balsawood bridge competition. Upon completion of the project, students travel to campus to test their bridges in a load-until-failure process. The second design project is a robotics competition, in which students design an autonomous maze navigation vehicle. The development platform is an Arduino-equipped Boe-Bot robotics kit (Parallax, Inc.), which contains a robot chassis, continuous rotation servos and wheels, an assortment of different sensors and electronic components, and an Arduino microcontroller board.

More details on the *Introduction to Engineering* curriculum and the results of its implementation are described by Langhoff, et al. [4]. The curriculum has been successful in enhancing students' identity as engineers as indicated by pre- and post-program surveys. The course also shows success in increasing students' self-efficacy and skills needed to succeed in college, as well as provide insight into the university transfer process and academic pathway post-transfer. As a result, students expressed increased self-efficacy in succeeding in their courses and increased ability to cope with and overcome doing poorly on a math exam.

Engineering Graphics

The online Engineering Graphics course developed through CALSTEP is a four-unit course (corresponding to 48-54 lecture hours plus 48-54 lab hours) designed to satisfy the introductory engineering graphics/graphics communication requirement for students intending to transfer to a four-year program in Civil Engineering, or Mechanical Engineering. Since community college engineering students transfer to a variety of universities in a range of majors, and to ensure articulation of the course with these universities, the course covers both the use of AutoCAD and SolidWorks. The course was designed for articulation with the statewide-approved course descriptor for Engineering Graphics as published in the course identification numbering system (c-id) website at https://c-id.net/view_final.html.

Online course materials that have been developed include PowerPoint lectures, lecture videos, video tutorials, laboratory exercises, and homework assignments. Most lecture videos and video tutorials were created and edited using a tablet computer and screen capture software such as Camtasia Studio. A total of 24 lecture videos and 32 video tutorials were created. The videos were designed to be short because short videos have been found to be more engaging [17]. Most of the lecture videos were between 15 to 20 minutes long, with the shortest video at 12 minutes long, and the longest at 28 minutes. The video tutorials (which include topics on AutoCAD, SolidWorks, and free-hand sketching) were shorter, with most videos between 8 and 12 minutes long, with the shortest video less than 5 minutes and longest video around 19 minutes long. Additionally, PowerPoint files for lectures were available, as well as PDF files for 24 laboratory exercises and homework assignments.

Implementation of CALSTEP Engineering Graphic course shows that students in the online course performed at least as well as the students in the face-to-face section [5]. With the same instructor teaching both the online and face-to-face sections, there were no statistically significant differences in the student performance and outcomes for the two sections [18]. With the updated Graphics curriculum, the retention and success rates for both the online and face-to-face sections were significantly higher than the previous Graphics courses for previous six academic years, which were all offered in the traditional face-to-face format. The course resources developed for the online Graphics course (PowerPoint lectures, lecture videos, video tutorials, laboratory exercises, and homework assignments), which were also made available to the face-to-face students have been effective in promoting student success in both the online and F2F sections. The results of the end-of-semester survey show very positive perceptions of the usefulness of the course materials and high levels of satisfaction with the course for both the online and face-to-face students [18].

Materials Science

The curriculum and resources for the CALSTEP Materials Science course were designed so as to: (a) align with a statewide course descriptor for a 4-unit (3-unit lecture and 1-unit lab) introductory materials science course for students in Aerospace, Civil, Mechanical, and Manufacturing Engineering; (b) allow flexibility for a variety of delivery formats (e.g., flipped, online, emporium, etc.); (c) require some minimum number of on-campus experiments in a traditional materials testing lab that would satisfy course objectives, yet provide a manageable solution for online students or for institutions lacking traditional materials testing equipment.

The initial curriculum and pilot implementation were designed around a flipped approach, in which students were expected to read from a textbook and view video lessons outside of class, and then use class time for group problem-solving sessions and laboratory experiments. In order to investigate student preferences regarding video formats, the initial set of video lessons consisted of both original content by the curriculum designer, as well as existing content produced by other instructors in a variety of formats (voice-over slides, brief screencast video modules, full-length lecture archives, etc.). For in-class activities, in addition to the lab curriculum, problem sets were developed to explore content in a team setting, and multiple-choice questions were written to provide brief formative assessment of individual learning of key concepts in each lesson.

More details on the CALSTEP Materials Science curriculum and the results of its implementation are presented by Dunmire, et al. [19]. Students demonstrated substantial learning gains according to multiple measures and achieved the learning outcomes in the course. Moreover, they found the lab experience highly rewarding, not only because it reinforced and contextualized the lecture content, but also because it conferred additional knowledge and skills beyond that covered in the text, lecture videos, and problem sets.

Circuits Lab

The lab development effort for the Circuits course was designed to provide student competencies in: instrumentation and measurement of circuit variables; evaluation of circuit models; devising experiments; collecting, analyzing, and interpreting data; designing, building, and assembling circuits; only in a remote, online-learner context. With an expectation that remote online learners working independently on circuit labs and out of sight of the instructor are liable to encounter overwhelming difficulties and be unable to resolve anomalous measurements, a guiding philosophy was adopted to: a) keep labs simple to the extent possible; b) aim to provide "fault proof" activities; and c) rely on the use of circuit simulation and other virtual lab opportunities for a greater proportion of the activities. Alongside the content, a set of support resources for online learners was also developed, including a set of studio video tutorials produced by a former student of the class, a discussion forum for posting questions and receiving answers, online office hours for students to ask questions of the instructor, and classroom videos guiding students through the non-hardware portions of the labs (simulation and analysis).

The development of the curriculum involved the design of the circuits laboratory kit, a low-cost, reusable, shoe-box sized container mailed (loaned) to online students at the start of the semester. Each unit contains a breadboard powered by two 12VDC wall adapters, a components kit with a relatively simplified set of parts, a DVM, a USB oscilloscope (Digilent's Analog Discovery), a speaker for audio experiments, and an Arduino microcontroller for sensor experiments. Using a 2.1 mm jack allowed for bringing DC power from the wall adapters directly to the breadboard. A 5V regulator combined with a potentiometer provides an adjustable voltage source for those experiments requiring one. Since the kits are provided free to students, most of the contents will be reused in future semesters, with the exception of the basic components, which can be refreshed for approximately $10/kit per semester. Although not included in the circuit kit, use of a web-based circuit simulator was another important component of the labs, providing students an intuitive, fault-tolerant user interface, while MATLAB (or a free, open-source equivalent) provides the computational support.

Details of the curriculum and the results of its implementation are presented by Rebold, et al. [20]. To assess the effectiveness of the curriculum, student learning outcomes and perceptions of the effectiveness of the lab content were evaluated. Although the level of achievement of student learning outcomes was roughly similar for the online and face-to-face students, the persistence of greater time requirements for online students to complete their labs is an ongoing area of need, in spite of the resources specifically targeting the online cohort, such as tutorial videos. Future implementations of the curriculum will focus on reducing the time requirements for online students to complete the labs by further developing resources to support them.

3. The Summer Engineering Teaching Institute

In addition to developing curricula and alternative strategies for delivering lower-division engineering courses at community colleges, another major activity of CALSTEP is the Summer Engineering Teaching Institute (SETI). SETI is a two-day teaching workshop that introduces community college engineering faculty to the CALSTEP curriculum, and assists faculty in implementing the curriculum and developing alternative teaching and learning strategies to increase enrollment and improve teaching effectiveness.

In introducing the use of tablet computer technology in teaching engineering courses, three instructional models were developed, all of which can be implemented in either a face-to-face or an online environment. In the *One-Tablet-PC* model, the tablet computer is used mainly by the instructor in lieu of the traditional chalk and blackboard to generate class notes during instruction. Advantages of this model over the traditional approach include: generation of electronic documents of lecture notes that are available for later distribution, ability to use enhanced graphics and annotation capabilities, and more efficient coverage of course material with time-consuming steps preloaded in the class presentation. In the *Several-Tablet-PCs* model, several tablet PCs are available for student use in groups of three or four. This model is effective in collaborative problem-solving sessions because it forces students to work together using a tablet computer to analyze problems and generate solutions. Each group can then be asked to present their solution, giving the class an opportunity to see multiple approaches to the problem, as well as identify common misconceptions and errors. The fully *Interactive Learning Network* requires each student to have access to a tablet computer use during lectures to allow real-time formative assessment of individual student learning. In addition to real-time assessment, various levels of two-way interactions between the instructor and individual students or groups of students, as well as among students within a given group can be developed. These interactions can enhance the instructor's ability to solicit active participation from all students during lectures, to conduct immediate assessment of student learning, and to provide needed real-time feedback and assistance either individually or in groups to maximize student learning.

As part of the SETI curriculum, *Synchronous Online Teaching* (wherein content is delivered simultaneously to on-campus students and online students) is also introduced. Synchronous delivery of lectures to online students can be achieved using Blackboard Collaborate, a multipoint videoconferencing software application that is available for use free of charge to all faculty and staff of the California Community College system through CCC Confer.

In addition to introducing workshop participants to the use of tablet and wireless network technologies to improve teaching effectiveness and efficiency, a major objective of SETI is to disseminate CALSTEP curriculum and assist community college engineering faculty in combining technology with the CALTEP teaching resources in order to increase the potential number of students that can be served through a combination of face-to-face and online delivery methods.

4. Results of Implementation of the Summer Engineering Teaching Institute

For the 2016 implementation of the Summer Engineering Teaching Institute, fifteen community college engineering instructors from twelve different California community colleges participated in the program. The first day of the program was devoted to the different models of Tablet PC-enhanced instruction. A session on developing a course on microcontrollers was also held in response to the newly approved statewide *Introduction to Programming* that has a lab component that focuses on microcontrollers.

The morning sessions of the second day were devoted to introducing the participants to the CALSTEP curricula. Because of the limited time, two concurrent sessions were held. For the first concurrent session, participants selected to attend the *Materials Science* group, or the *Circuits* group. For the second concurrent session, participants had to choose between *Intro to Engineering* or *Graphics*. As a result, each participant had the opportunity to learn only two of the four CALSTEP courses. The afternoon session of the second day was devoted to individual presentations done by participants. Each participant was given 10 minutes to do a presentation that demonstrates teaching techniques, materials, and resources that they have learned from the workshop, and their plans to incorporate what they have learned into their teaching. In preparing for the presentation, the CALSTEP team provided technical assistance and pointers to the participants. The individual presentations gave the participants the opportunity to learn using their new tablet computers for teaching and presentations, as well as practice implementing SETI teaching resources and explore ways to improve their teaching.

At the end of the workshop, a survey was given to the participants to assess their opinions on the success of SETI in achieving its program goals. The survey focuses on three separate areas. The first area of focus was the likelihood that the participants will incorporating elements of the SETI intro their teaching. The second group of survey questions attempted to assess the participants' perception of the usefulness of the different components of the SETI program. Finally, the participants' level of satisfaction with the different aspects of the program was also measured.

Table 1 shows a summary of the responses of the 2016 SETI participants to a post-program survey question on the likelihood of incorporating SETI curriculum elements into their teaching. The results show that curriculum components that include the use of tablet computers for either delivering lectures (using MS Office or PDF Annotator), or creating content (using Camtasia) were the most likely to be adopted by the participants. On the other hand, software applications for a fully interactive tablet-pc-enhanced classroom (NetSupport School) is the least likely to be adopted due to the need for students to have individual access to tablet PCs during class for this software application to be relevant. With respect to the CALSTEP curriculum, Material Science is the most likely to be implemented, followed by Graphics, then Circuits, and Intro.

Table 1. 2016 SETI post-program survey results on likelihood of incorporating workshop elements. Question: How likely are you to incorporate the following in your courses in the next academic year? (Response Scale: 1 – Not likely; 2 – Somewhat likely; 3 – Likely; 4 – Very Likely)

SETI Curriculum Elements	Average Response
Tablets and MS Office	3.47
PDF Annotator	3.47
Video Capture with Camtasia	3.33
Materials Curriculum	3.11
CCC Confer for Lectures	3.07
3C Media	3.07
Flipping the Classroom	2.87
Graphics Curriculum	2.83
Intro to Engineering Curriculum	2.71
CCC Confer for Office Hours	2.60
Circuits Curriculum	2.50
Intro to Programming with Microcontrollers	2.38
NetSupport School	2.15

Table 2 summarizes the responses of the 2016 SETI participants to the question on the usefulness of specific SETI activities. The activities that were perceived to be the most useful are the workshop on 3D printing and the Materials Science curriculum, followed by the Graphics curriculum, and the two workshops on using tablets to deliver content (Tablets and MS Office; PDF Annotator). The Circuits curriculum follows, and then video capture and flipping the classroom. The workshop on microcontrollers and the session on individual presentations were perceived to be the lease useful, although with an average response of 3.27, these two sessions are still viewed as being between “useful” and “very useful”.

Table 2. 2016 SETI post-program participant survey results on usefulness of workshop topics. Question: How useful was each of the following workshops? (Response Scale: 1 – Not useful at all; 2 – Somewhat useful; 3 – Useful; 4 – Very useful)

SETI Activities	Average Response
3D Printing	4.00
Materials Science Curriculum	4.00
Graphics Curriculum	3.89
Tablets and MS Office	3.80
PDF Annotator	3.80
Circuits Curriculum	3.75
Video Capture & Flipping the classroom	3.73
CCC Confer Basics	3.67
Projects for Intro Class	3.67
Intro to Engineering Curriculum	3.63
Making Lectures Interactive	3.29
Intro to Programming with Microcontrollers	3.27
Individual Presentations	3.27

For the 2017 implementation of the Summer Engineering Teaching Institute, ten community college engineering instructors from ten different California community colleges participated in the program. Modifications on the SETI agenda were made based on participants' feedback from the 2016 SETI. In order to allot more time to exploring the CALSTEP curricula on the four lower-division engineering lab courses (at least two hours each for Intro, Graphics, Materials Science, and Circuits), the session on individual presentations done by SETI participants the previous year was eliminated. Workshops on exploring the CALTEP curricula were combined with sessions on using tablet-pc technology and online teaching. The morning session of the first day was devoted to the *Intro to Engineering* curriculum together with a workshop on using tablet computers for delivering course content using MS Office. The afternoon session of the first day was spent on the CALSTEP Circuits curriculum, as well as creating content using PDF Annotator, screen capture using Camtasia Studio, and implementing flipped classrooms.

For the second day of the 2017 SETI, the morning workshops included exploring the Graphics curriculum, delivering content online (Confer Zoom, CCC Confer, and 3C Media Solutions) and implementing a fully interactive tablet-enabled learning network using NetSupport School. The afternoon session of the second day of 2017 SETI focused on the Materials Science curriculum, as well as a group discussion on how to implement CALSTEP curriculum and an evaluation of SETI.

Table 3. 2017 SETI post-program survey results on likelihood of incorporating workshop elements. Question: How likely are you to incorporate the following in your courses in the next academic year? (Response Scale: 1 – Not likely; 2 – Somewhat likely; 3 – Likely; 4 – Very Likely)

SETI Curriculum Elements	Average Response
Tablets and MS Office	4.00
Confer Zoom; CCC Confer; 3C Media	4.00
PDF Annotator	3.90
Video Capture , Camtasia	3.90
CALSTEP Circuits Curriculum	3.90
NetSupport School	3.90
CALSTEP Materials Curriculum	3.90
CALSTEP Intro to Engineering Curriculum	3.80
CALSTEP Graphics Curriculum	3.70

Table 3 shows a summary of the responses of the 2017 California SETI participants to a post-program survey question on the likelihood of incorporating SETI curriculum elements into their teaching. Compared to the average responses from the 2016 SETI (Table 1), the 2017 SETI participants' opinions of the likelihood of incorporating SETI workshop activities were more positive. Average responses from 2017 ranged from 3.70 to 4.00 compared to 2016 responses ranging from a minimum of 2.15 to a maximum 3.47. For both years, the use of tablets and MS Office to deliver course content was rated as the SETI activity that was mostly to be implemented. With respect to the likelihood of incorporating CALSTEP curriculum in their teaching, 2017 SETI participants indicated high likelihood that they will incorporate the curriculum in their teaching (response range: 3.70 to 3.90), especially when compared to 2016 responses (response range: 2.71 to 3.11). These results seem to indicate that the 2017 SETI program was more successful in its goal of disseminating the CALSTEP curriculum for adoption. This can be attributed to the increased emphasis given to the CALSTEP curriculum in the 2017 SETI (at least two hours for each of the four courses). Furthermore, for in 2017, all participants attended workshops for all four of the CALSTEP courses, unlike the 2016 SETI wherein participants had the opportunity to learn about only two of the four courses.

Table 4 summarizes the responses to the question on the usefulness of specific 2017 SETI activities. Among the activities that were perceived to be the most useful were the workshops on using tablets to create course content (video capture, PDF Annotator), workshops on using tablets to deliver content (PDF Annotator, Tablets and MS Office). For workshops on implementing online courses, CCC Confer was perceived to be the least useful compared to 3C Media and Confer Zoom. This is due to the fact that less emphasis was given to CCC Confer because of the uncertainty on whether CCC Confer will continue to be supported by the California Community College Chancellor's Office beyond 2017. With respect to workshops on the four CALSTEP courses, Materials Science was perceived to be the most useful, followed by Intro to Engineering, Circuits, and then Graphics.

Table 4. 2017 SETI post-program participant survey results on usefulness of workshop topics. Question: How useful was each of the following workshops? (Response Scale: 1 – Not useful at all; 2 – Somewhat useful; 3 – Useful; 4 – Very Useful)

SETI Curriculum Elements	Average Response
Video Capture with Camtasia	3.80
PDF Annotator	3.70
3C Media	3.50
Tablets and MS Office	3.40
CALSTEP Materials Curriculum	3.40
CALSTEP Intro to Engineering Curriculum	3.30
Confer Zoom	3.20
CALSTEP Circuits Curriculum	3.10
CALSTEP Graphics Curriculum	3.00
NetSupport School	2.67
CCC Confer	2.50

Table 5 summarizes the responses of the 2016 and 2017 SETI participants to the post-program survey questions that assess their level of satisfaction with the length/duration of the program, overall quality of the workshops, knowledge and helpfulness of workshop facilitators, and the overall usefulness of SETI. It can be observed that the levels of satisfaction are higher for the 2017 cohort compared to those for the 2016 cohort. These improved levels of satisfaction can be attributed to the improvements implemented by the CALSTEP team in 2017 based on the feedback from the 2016 SETI participants. For both years, the lowest rating was for the length/duration of the program, with most participants indicating that more time was needed to learn and practice all the materials and resources introduced.

Table 5. SETI post-program participant survey results on level of satisfaction. Question: How satisfied are you with each of the following? (Response Scale: 1 – Very dissatisfied; 2 – Dissatisfied; 3 – Neutral; 4 – Satisfied; 5 – Very satisfied)

SETI Program Elements	**Average Response**	
	2016	**2017**
Length/Duration of SETI	4.33	4.40
Overall Quality of Workshops	4.67	5.00
Knowledge/Helpfulness of Workshop Facilitators	4.87	5.00
Overall Usefulness of SETI	4.93	5.00

In addition to providing the knowledge and resources needed by SETI participants to implement what they have learned, CALSTEP also aims to assist workshop participants identify and address factors that could serve as barriers to successful implementation of SETI curriculum components in the classroom. Table 5 shows a summary of participant responses to the survey question on barriers to the adoption of SETI resources and practices. For both 2016 and 2017 SETI, the biggest perceived barrier is the time required to implement what they have learned, with 66.7% of the 2016 participants and 90% of 2017 participants selecting this factor as a barrier. For the 2016 participants, the other factors were perceived as less of a barrier to implementation, with cost being selected by only one-third of the participants. For the 2017 SETI, the lack of support from administrators was selected by 50% of the participants as a barrier to implementation, while 40% identified lack of support from colleagues was perceived as a barrier.

Table 6. SETI post-program participant survey results on perceived barriers to adoption of SETI resources and practices. Question: Which of the following factors are barriers to your adoption of resources and practices you have learned in SETI?

Factors/Barriers	**2016**		**2017**	
	N	**%**	**N**	**%**
Time required to implement them	10	66.7%	9	90.0%
Cost	5	33.3%	2	20.0%
Lack of experience/confidence in using technology/resources	4	26.7%	2	20.0%
Lack of support from my college administrators	3	20.0%	5	50.0%
Lack of support from colleagues in my department/division/college	2	13.3%	4	40.0%
I did not learn enough from the workshop.	1	6.7%	0	0.0%

To further investigate the perceived barriers to adoption of SETI curriculum elements, a focus group among the 2017 SETI participants was held. The one-hour long facilitated conversation was organized around three themes. The first theme was an exploration of how SETI participants planned to move forward with the new technologies and instructional approaches that SETI had introduced. The second theme concerned how the participants expected their students to respond to the introduction of SETI technologies and instructional methods. The third theme was about feedback and ideas, asking what participants liked about SETI, how a SETI community could be developed and sustained, and what could be done to strengthen the next iteration of SETI.

Several participants identified as their next steps organizing and testing the new resources, preparing kits for fall semester circuits and introductory courses, and practicing applications of Camtasia, PDF Annotator and AutoCAD. Several participants also planned to spend part of the summer experimenting with video production. Some participants spoke more about integrating existing SETI resources into their courses than about creating new material, but most expressed interest in developing new curriculum and tutorials. Most participants said they would take quick action to introduce their SETI resources and knowledge to their deans and other administrators, some feeling confident that their own enthusiasm would be matched by their department and division heads, while others anticipated less support and a few even resistance.

Regarding the theme of student possible response to SETI curriculum, participants had little doubt that their students will respond positively to the use of more technology in the classroom and in labs. The participants agreed that the students do not need to be convinced about the benefit of increasing the use of technology. An experienced user of technology cautioned that home-video watching assignments is one area where technology does not work well for all students. Many students need guidelines and instruction to become active watchers of video lecture. The facilitator asked the participants if they thought students were aware of the online engineering courses they can take at colleges around the state. The participants agreed that there is very limited awareness among students about these options.

When asked about what the participants liked best about SETI, many participants appreciated the sense of community and support. The participants spoke very highly of the SETI experience. There was widespread agreement that SETI had introduced them to new ways of instruction and made available to them technologies that they were eager to test in their own teaching practice. Participants were also very appreciative about the resources they were given.
In terms of improvements, the number one input was a request for more time to practice. It was suggested that a third day be added to the SETI agenda to provide opportunities to practice the new skills and technologies and ask questions. A few participants felt the pace in some of the sessions was so fast that they got lost by the wealth of resources and materials presented. Among the ideas presented on how to create and sustain a SETI community was to meet at the Engineering Liaison Council meetings since many SETI participants attend this twice-a-year event. Additional ideas concerned the development of a virtual community through Zoom conferences and webinars. There was also enthusiasm expressed about the idea of introducing the two SETI cohorts to each other. The participants wanted to know what the first cohort of SETI participants have learned and what advice they have.

5. Conclusions and Future Plans

The first three years of implementation of the CALSTEP program has been successful in achieving its major goals. Curriculum for the four lower-division engineering courses that are focus of the project have been developed, successfully implemented, and revised for improvement. Alternative delivery methods (fully online, hybrid, flipped, and emporium) have also been successfully piloted, and have been shown to achieve the course student learning outcomes. The CALSTEP team has also been busy disseminating the curriculum and promoting their wide adoption at California community colleges. Two years of implementation of the Summer Engineering Teaching Institute have resulted in significant interest among community college engineering faculty to implement the CALSTEP curriculum and develop engineering courses using technology introduced through SETI. CALSTEP curriculum materials are available at the project website (https://canadacollege.edu/nsf-iuse/).

As a result of the lessons learned from the first two years of implementation of SETI, the 2018 SETI will be extended to three full days. The last day of the program will be devoted to practicing the use implementation of the tools learned during the first two days, and hands-on exploration of specific CALSTEP curriculum components of interest to the participants. The extra day will also give the opportunity to address participants' questions and concerns as they experiment on the tools and resources that they have learned.

Considerable resources will also be devoted by the CALSTEP team to building a community among SETI participants and others who have adopted the CALSTEP curriculum at their local institutions. A follow-up survey and interviews of SETI participants will be done to assess the progress they have made in integrating SETI resources and implementing SETI teaching strategies at their colleges, as well as the challenges they have faced and the ways that the CALSTEP project can support them. Efforts will also be made to address and respond to the priorities and concerns raised during the 2017 SETI participant focus group including: a) documentation of the number of engineering students enrolled in the California community colleges and the transfer numbers these students generate; b) documentation of how many students in more advanced math and physics courses are engineering transfer-bound students; c) examples of online courses offered by community colleges that are accepted by transfer institutions; d) evidence of effectiveness of online instruction; and e) a catalogue/listing of online engineering courses that are open to enrollment for students around the state. Finally, the CALSTEP team will have as one of its priorities connecting with organizations (e.g., the California Online Education Initiative, or OEI) to find resources to support the effort to disseminate the CALSTEP resources and prepare additional faculty to use the resources in their classrooms.

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