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Strengthening Community College Engineering Education Through Collaboration and Technology

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Abstract

There has been a recent increase in awareness of the important role that community colleges play in educating future engineers, especially in broadening participation among students from underrepresented groups. However, budget problems at the state and national levels have resulted in continuing budget cuts in community colleges. With limited resources while responding to increasing variability of lower-division transfer curricula as required by four-year engineering programs, it has become increasingly difficult for small community college engineering programs to support all the courses needed by students to transfer. Meanwhile, transfer admissions have become increasingly more competitive because of budget cuts in four-year universities. As a result, prospective engineering students who attend community colleges with limited or no engineering course offerings are at a disadvantage for both transfer admission as well as time to completion upon transfer. This paper is a description of a collaborative project among community college engineering programs in California to address this problem by aligning engineering curriculum, enhancing teaching effectiveness using Tablet PCs, and increasing access to engineering courses through online education. The project includes a Summer Engineering Teaching Institute designed to assist community college engineering faculty in developing a Tablet-PC-enhanced model of instruction, and implementing online courses. The project also involves a partnership among California community college engineering programs to design and implement a Joint Engineering Program that is delivered online. This paper summarizes the results of the first two years of implementation of the project, and explores its potential to strengthen the community college engineering education pipeline in order to increase and diversify the engineering workforce.

1. Introduction

The 2012 President's Council of Advisors on Science and Technology (PCAST) report, "Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics," indicates that the United States needs to produce one million additional STEM professionals in the next decade in order to retain its historical preeminence in science and technology. To meet this need, the number of undergraduate STEM degrees will have to increase by about 34 percent annually over the current rates. The PCAST report proposes that addressing the retention problem in the first two years of college is the most promising and cost-effective strategy to address this need.[1] The California Community College System, with its 112 community colleges and 71-off campus centers enrolling approximately 2.6 million students—representing nearly 25 percent of the nation's community college student population—is in a prime position to help address the need for the future STEM workforce.[2]

The critical role that community colleges play in building a larger and more diverse workforce that is educated in STEM fields has long been recognized.[3] Specifically, community colleges are an important source of prospective engineering students for several reasons: (1) millions of students attend them; (2) many women and students from underrepresented minorities attend community colleges; and (3) many community college students in engineering do not transfer to four-year engineering programs after earning their two-year degree.[4]

For years, the 2+2 concept, wherein students are able to complete all of their lower-division coursework at a community college and then transfer to a four-year institution to complete a bachelor's degree, worked well for community college engineering students in California. In 2002, the California Council on Science and Technology reported that 48 percent of graduates with engineering degrees from the California State University (CSU) and University of California (UC) systems began at community colleges and then transferred.[5] This was made possible by a common set of lower-division courses—commonly referred to as "the core"—required by four-year engineering programs and replicated at community colleges. Students were able to start their engineering coursework at a local community college with the option of transferring to one of the many four-year schools across the state.

Recently, the diversification of transfer requirements among university engineering programs has led to the erosion of the core, and has increased the number of courses that community colleges must offer in order to maintain transfer options to different engineering majors and different universities. The diversification includes variability of requirements for students in the same major transferring to different institutions, as well as for students in different majors transferring to the same university, and has resulted in declining enrollments in community college engineering programs.[6] The erosion of the core lower-division engineering curriculum, coupled with recent budget crises in California, is threatening the viability of community college engineering programs all over the state. In response to this pressing need to strengthen community college engineering programs, Cañada College, submitted a successful grant proposal to the National Science Foundation. This paper is a description of this NSF-funded project that attempts to improve community college engineering education using technology, and establish collaborations and partnerships among institutions in order to increase the viability of community college engineering programs in the state.

2. Struggling California Community College Engineering Programs

Engineering is an important transfer program in California community colleges, with over 100 community colleges that have students who transfer to four-year schools as engineering majors. However, the numbers of these transfer students have been decreasing. Figure 1 shows the distribution of California community college students who transferred to University of California (UC) and California State University (CSU) in 2010 as engineering majors. Of the 104 colleges with engineering transfers, the average number of transfers from a college was 19.6 students, and the median was 16.0 students. In fact, 82 of the 104 colleges transferred less than 30 students, and 65 colleges had fewer than 20 transfers each. In light of the current budget crisis in California, a significant number of these small engineering programs will have difficulty sustaining their programs due to cancellation of courses with low enrollments.

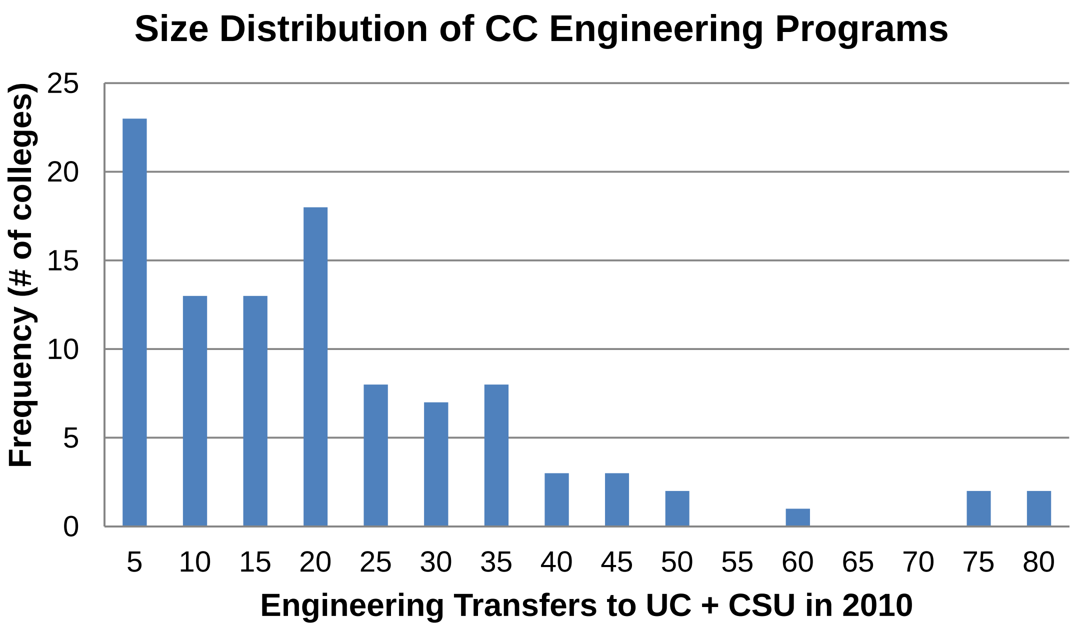

Figure 1. Distribution among individual California Community Colleges of engineering transfers to UC and CSU in 2010. Of the 104 colleges with engineering transfers, 82 colleges transferred less than 30 students each, accounting for 52% of the 2,014 total transfers. Median number of transfers = 16.0 students; Mean number of transfers = 19.6 students. Data are from California Postsecondary Education Commission.[7]

An analysis done by Dunmire, et al., shows that the increasing diversification of the transfer requirements of California university engineering programs, coupled with the lingering budget crisis is threatening the viability of most California community college engineering programs. The analysis considered a typical medium-sized San Francisco Bay Area community college engineering program that has an annual 25 transfer students who are transferring to the four most popular universities in the four most popular engineering majors (civil, computer, electrical, and mechanical). Of the 14 different community college engineering courses included in the analysis, only one (Circuit Analysis Lecture) was projected to have a viable enrollment of about 19 students per year, with 9 out the 14 courses projected to have an enrollment of less than 10 students per year.[6] With the majority of community college engineering programs not able to offer the lower-division courses needed by students to transfer, many community college students will not have access to engineering education, and others will be vastly unprepared when they transfer to a four-year program.

3. Online and Networked Education for Students in Transfer Engineering Programs

To address the problems resulting from the gradually decreasing ability of California community college engineering programs to support the courses needed for transfer, and produce enough successful transfer engineering students, Cañada College, a Hispanic-serving community college in the San Francisco Bay Area, has developed the Online and Networked Education for Students in Transfer Engineering Programs (ONE-STEP). Funded by the National Science Foundation

Innovations in Engineering Education and Curriculum Infrastructure (NSF IEECI) grant program, the project has two main focus areas for achieving program goals. The first one is the use of Tablet PCs to improve the effectiveness of engineering education, and to develop online instruction to increase productivity and improve viability of community college engineering programs. The second focus area is developing partnerships with community colleges without an engineering program to design a joint engineering curriculum that is delivered through distance education, as well as establishing collaboration among existing community college engineering programs to better serve community college students interested in pursuing degrees in engineering.

Tablet-PC Enhanced Instruction

For the last several years, Tablet PCs have gained increased popularity in engineering education. The functionality of simulating paper and pencil by allowing the user to use a stylus and write directly on the computer screen to create electronic documents that can be easily edited using commonly available computer applications makes Tablet PCs more suitable than laptop computers in solving and analyzing problems that require sketches, diagrams, and mathematical formulas. Combined with wireless networking technology, Tablet PCs have the potential to provide an ideal venue for applying previously proven collaborative teaching and learning techniques commonly used in smaller engineering laboratory and discussion sessions to a larger, more traditional lecture setting. Currently, the range of use of Tablet PCs in the classroom includes enhancing lecture presentations,[8-10] lecture capture,[11-13] collaborative learning,[14-16] creating a more interactive classroom environment,[17-23] formative assessments,[24-30] and distance education.[31-33]

As part of the ONE-STEP program, a Summer Engineering Teaching Institute (SETI) has been developed to help California community college engineering instructors use various Tablet-PC-enhanced models of instruction. The SETI curriculum includes the following instructional models of Tablet-PC use:

a. One-Tablet PC model wherein the Tablet PC 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. The single Tablet PC can also be passed around the classroom to allow students to show their work without having to "come up to the board."

b. Several-Tablet-PCs model wherein 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 PC 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.

c. Individual Student Tablet PC use for Real-Time Assessment. This model requires each student to have access to Tablet PC use during lectures to allow real-time formative assessment of individual student learning. This is an enhanced version of the Personal Response System (PRS),[34] which only allows multiple-choice or short-answer questions. With a Tablet PC, individual student responses may also be submitted as sketches, and numerical solutions with multiple steps.

d. Fully Interactive Learning Network. For this instructional method, in addition to real-time assessment as in the previous model described above, 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 are 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.

Synchronous Online Teaching

Online teaching is one of the fastest growing trends in educational technology in the U.S. A recent study of online education indicates that online enrollments are growing at substantially faster rates than overall higher education enrollments (10.1% vs. 0.6%), with over 6.1 million students (or 31.3% of all U.S. higher education students) taking at least one online course in the fall of 2011.[35] In the November 2011 report on distance education issued by the California Community College Chancellor's Office,[36] it was reported that among California community colleges, distance education has grown at a significant rate over the last five-years, doubling in the number and percentage of course sessions, as well as student enrollments.

A study of the effectiveness of dual delivery mode (content is delivered simultaneously to on-campus students and online students) in an Introductory Circuits Analysis course shows no statistically significant difference in the levels of performance of the online and on-campus students despite favorable demographics for the on-campus group.[37] In this study, synchronous delivery of lectures to online students is achieved using Blackboard Collaborate (http://www.blackboard.com/), 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.[38] Online students also rated their experience in this online class to be better than other online courses they have previously taken. These results are particularly promising for a small engineering program where budget cuts and low enrollments threaten the viability of course offerings and the program itself.

The ONE-STEP project uses the above model of synchronous delivery using CCC Confer to help small community college engineering programs in California to increase their teaching productivity, as well as provide the opportunity for community colleges without engineering programs to offer core lower-division engineering courses to their students by expanding the pool of potential students through distance education. Community college engineering faculty selected to participate in the Summer Engineering Teaching Institute will be trained to use Tablet PCs and CCC Confer to develop this instructional delivery mode.

Developing a Joint Engineering Program

A third major goal of the ONE-STEP program is to develop partnerships with community colleges without an engineering program to design and implement a joint engineering program that is delivered through CCC Confer, and allows students from any of the collaborating institutions to take courses offered online through the partnership. It will also establish collaboration among existing engineering programs to align the engineering curriculum in order to better serve students.

The CA Engineering Liaison Council website[38] lists less than 80 community colleges with engineering programs out of the 112 colleges in the California Community College system. Many of these programs only offer one or two courses every semester. It is the goal of ONE-STEP to improve these community colleges' ability to offer a full range of lower-division engineering courses needed for transfer. This will make their students more competitive in the transfer process, and reduce the time that these students need to spend in four-year institutions to complete their degrees. This has the potential to increase the number of future engineers in the engineering educational pipeline while reducing the cost of their education.

4. Results: The Summer Engineering Teaching Institute

The curriculum for the Summer Engineering Teaching Institute has been developed and was first offered in June 2011. Engineering faculty from the following institutions attended the 2011 SETI at Cañada College: Allan Hancock College, Chabot College, College of Marin, College of San Mateo, Evergreen Valley College, Fullerton College, Las Positas College, Los Angeles Pierce College, Mission College, Ventura Community College, and Willow International Center (Reedley College). Workshop topics included Tablet PC models of instruction, online curriculum using CCC Confer, and use of technology in engineering education. A WebAccess Moodle website for SETI containing workshop materials and presentations has been developed (https://smccd.mrooms.net/course/view.php?id=35666). Participants have been granted instructor privileges to encourage exchange of ideas to continue after the workshop and allow participants to upload content that they have developed.

Table 1 shows a summary of the responses of 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 CCC Confer either for delivering lectures, or archiving lectures, or conducting online office hours are the most likely to be adopted by the participants. Software applications for creating and delivering lectures using a Tablet PC (OneNote and Windows Journal) are the next group of applications most likely to be adopted. On the other hand, software applications such as InkSurvey Tool and NetSupport School are the least likely to be adopted due to the need for students to have individual access to Tablet PCs during class for these software applications to be relevant. Poll Everywhere, an Internet-based student response system that allows various student input devices (including cell phones) is also not likely to be adopted. This may be due to cell phone use during class being unacceptable to most of the participants.

Table 1. 2011 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
CCC Confer for Lectures	3.64
Archiving Lectures Using CCC Confer	3.55
CCC Confer for Office Hours	3.09
OneNote	3.09
Windows Journal	2.82
Mastering Engineering	2.55
Apply for grant funding	2.55
PDF Annotator	2.50
SnagIt	2.50
Jing or Camtasia	2.45
Facebook	2.09
InkSurvey Tool	2.00
Poll Everywhere	1.82
NetSupport School	1.82

Table 2 summarizes the responses to the question on the usefulness of specific SETI activities. Among the activities that were perceived to be the most useful are the individual presentations wherein each participant prepared and delivered a 10-minute presentation on specific topics using specific SETI curriculum elements. Activities involving CCC Confer were also highly rated. The activity on NetSupport School again received the lowest rating due to the need for individual student access to Tablet PCs.

Table 2. 2011 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
Individual Presentations	3.82
OneNote/CCC Confer	3.73
CCCConfer Basics	3.55
Jing	3.45
Mastering Engineering	3.36
Alan Hancock College Tablet PC usage	3.20
Facebook; Poll Everywhere	3.10
Camtasia; Writing Pads	3.09
Winpoint/SnagIt	3.00
NSF Funding Opportunities	2.91
Netsupport	2.90

For 2012, two sessions of the SETI were offered—the Northern California SETI held at Cañada College for faculty from community colleges in Northern California, and the Southern California SETI for community colleges in the south. This expanded SETI program was made possible by a new grant initiative "California Alliance for the Long-term Strengthening of Transfer Engineering Programs (CALSTEP)" funded by the US Department of Education grant through the Hispanic-Serving Institution Science, Technology, Engineering, and Mathematics (HSI STEM) program.

The 2012 Northern California SETI held at Cañada College on May 29-31 had 26 participants. Workshop participants were engineering, math and physics instructors from the following community colleges: Cabrillo College, Canada College, College of Marin, College of San Mateo, College of the Sequoias, Contra Costa College, De Anza College, Foothill College, Foothill College, Las Positas College, Los Medanos College, Mission College, Monterey Peninsula College, Napa Valley College, Sacramento City College, Santa Ana College, Santa Rosa Junior College, Skyline College, West Valley, Willow international Center (Reedley College), and Yuba College. The Southern California SETI held at Los Angeles Pierce College on June 17-19 had 15 participants from the following community colleges: Allan Hancock College, College of the Canyons, College of the Desert, East Los Angeles College, Fullerton College, Long Beach City College, Los Angeles Pierce College, Modesto Junior College, Moorpark College, and Ventura College.

The 2011 SETI curriculum was revised for 2012 based on the feedback received from 2011 participants. Additionally, for the 2012 Northern California SETI, additional workshops and presentations were developed to accommodate the needs of the several mathematics and physics instructors who participated, and to allow the participants to break into smaller groups and attend concurrent sessions.

Table 3. 2012 Northern California 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**
PowerPoint	3.89
CCC Confer for Online Lectures	3.29
Archiving CCC Confer sessions	3.14
Video Capture with Jing	2.93
CCC Confer for Office Hours	2.82
PDF Annotator	2.64
OneNote	2.50
Video Capture with Camtasia	2.39
Windows Journal	2.36
Google Docs	2.32
Mastering Engineering	2.11
NetSupport School	2.00
Online Labs	1.89
TutorMe	1.68
Geogebra	1.64
InkSurvey Tool	1.57

Table 3 shows a summary of the responses of the 2012 Northern California SETI participants to a post-program survey question on the likelihood of incorporating SETI curriculum elements into their teaching. Just like the 2011 results, curriculum components that include the use of CCC Confer for delivering online lectures, archiving of lectures and for online office hours, or the use of CCC Confer in combination with PowerPoint are the most likely to be adopted by the participants. Software applications such as NetSupport School, SynchronEyes, TutorMe, and InkSurvey Tool are the least likely to be adopted due to the need for individual student access to Tablet PCs to implement these applications.

Table 4 summarizes the responses to the question on the usefulness of specific 2012 Northern California SETI activities. Among the activities that were perceived to be the most useful are the workshops on using CCC Confer, the presentation on using PowerPoint and CCC Confer for lecture presentations, Geogebra workshop for math instructors, and the presentation on online labs. Workshops on applications that require individual student access to Tablet PCs (NetSupport School, InkSurvey, TutorMe, and SynchronEyes) again received the low ratings.

Table 4. 2012 Northern California 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**
CCC Confer	3.75
PowerPoint and CCC Confer	3.54
Geogebra	3.44
Online Labs	3.42
Video Capture with Jing	3.39
Working on Individual Presentations	3.38
Mastering Engineering	3.26
Windows Journal	3.26
PDF Annotator	3.24
Video Capture with Camtasia	3.21
Individual Presentations	3.15
OneNote	3.04
NetSupport School	3.04
InkSurvey Tool	2.95
Google Docs	2.89
TutorMe	2.79
SynchronEyes	2.63

In addition to providing the knowledge and resources needed by SETI participants to implement what they have learned, ONE-STEP 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. This was accomplished through group discussion and through a post-program survey. Table 5 shows a summary of participant responses to the survey question on barriers to the adoption of SETI resources and practices. For both 2011 and 2012 SETI, the biggest perceived barrier is the time required to implement what they have learned, followed by the cost of implementing them.

Table 5. 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	**2011**		**2012**	
	N	**%**	**N**	**%**
Cost	8	73%	12	46%
Time required to implement them	11	100%	20	77%
Lack of experience/confidence in using technology/resources	3	27%	12	46%
Lack of support from colleagues in my department/division/college	4	36%	6	23%
Lack of support from my college administrators	3	27%	5	19%

To further investigate the perceived barriers to adoption of SETI curriculum elements, a focus group among the 2012 Northern California SETI participants was held. A summary of the results of this focus group is given in Appendix 1. Among the potential barriers that were identified are time required for grading (download, markup, upload assignments); keeping student engaged, involved, and participating; poor attrition and engagement in online classes; and technical problems (e.g., stylus/microphone, computer connection). Among the strategies identified during the focus group to overcome these barriers for adoption are: build on the material that was developed last year; instituting a mandatory orientation for online students; continuing to experiment and practice; allowing more time prior to start of term to develop material; and allowing for more preparation time.

5. Results: Joint Engineering Program

For the first year of the Joint Engineering Program, engineering programs from six partner institutions were involved in aligning the lower-division engineering curriculum. The six collaborating institutions were Cañada College, Cabrillo College, College of Marin, Mission College, Pierce College, and West Valley College. Engineering courses in the lower-division engineering curriculum were aligned with respect to number of units, prerequisites, catalog description, student learning outcomes, and course outline/topics. Curriculum work is done through monthly online meetings among JEP institutions. To facilitate the collaboration of among the partner institutions, a Moodle WebAccess website has been created to allow participants to upload documents, use online forums for discussion, and use Wikis to revise documents (https://smccd.mrooms.net/course/view.php?id=35667). Additionally, the JEP partners met during semi-annual Engineering Liaison Council meetings.

In fall 2011, six online engineering courses at three of the participating institutions were offered through JEP. Drafts of course descriptors for 8 engineering courses (Statics, Circuits, Circuits Lab, Introduction to Engineering, Graphics, Materials Science, Dynamics, and Surveying), and drafts for Transfer Model Curriculum for two engineering tracks (Aerospace, Civil, Mechanical and Manufacturing Engineering for one track; and Electrical and Computer Engineering for the other track) have been developed through the Joint Engineering Program.

As of fall 2012, the Joint Engineering Program has increased the number of collaborating community colleges from 6 to 16. The JEP institutions are Allan Hancock College, Cabrillo College, Cañada College, College of Marin, College of San Mateo, Cosumnes River College, East Los Angeles College, Fullerton College, Las Positas College, Los Angeles Pierce College, Mission College, Monterey Peninsula College, Sacramento City College, Santa Rosa Junior College, Ventura College, and West Valley. Curriculum for engineering courses are aligned with respect to number of units, prerequisites, catalog description, student learning outcomes, and course outline/topics. A total of 14 online courses are offered at four of the JEP institutions for the 2012-2013 academic. The JEP has completed aligning curriculum and has developed course descriptors (C-IDs) for 11 lower-division engineering courses, as well as Associates in Science degree and Transfer Model Curriculum (TMC) in two areas: Mechanical/Civil Engineering, and Electrical/Computer Engineering. These course descriptors and TMCs have served as the starting framework for the statewide Course Identification Numbers (C-IDs)[39] and Transfer Model Curricula required under California Senate Bill 1440. This bill, which establishes the Student Transfer Achievement Reform Act, requires that a student who receives an "associate degree for transfer" be deemed eligible for transfer into a California State University. This bill is intended to streamline the transfer process for community college students.[40] At the time of writing this paper, the C-IDs and TMCs are undergoing the vetting process wherein faculty from community colleges and California State Universities throughout the state are given the opportunity to review and give feedback before finalizing the C-IDs and TMCs.

6. Conclusion and Future Plans

The first two years of implementation of the ONE-STEP program has been successful in achieving its major goals. The Summer Engineering Teaching Institute has been held three times, twice in Northern California, and once in Southern California, serving a total of 52 participants from all over California. SETI participants received training in using Tablet PCs for engineering, math and physics, and developing online courses using CCC Confer. These instructors have incorporated elements of the SETI curriculum in their engineering courses, and will be invited to future workshops to share their experiences in applying SETI teaching models at their home institutions. Results of the post-program survey will be used to improve the SETI curriculum.

The work done in developing the Joint Engineering Program has also yielded some encouraging results in aligning course descriptions, prerequisites, course outlines, and student learning outcomes. Course descriptors for eleven engineering courses and Transfer Model Curriculum for two engineering tracks (Aerospace, Civil, Mechanical and Manufacturing Engineering for one track; and Electrical and Computer Engineering for the other track) have been developed by the JEP partner institutions, and have been used as the basis for developing state-wide documents needed to address the mandate of SB 1440. Online courses at four of the participating institutions have been offered through JEP, and a few more courses are in development.

In October 2011, Cañada College was awarded a US Department of Education grant through the Hispanic-Serving Institution Science, Technology, Engineering, and Mathematics (HSI STEM) grant program. This new grant-funded project (CALSTEP) has enabled the ONE-STEP program to expand and continue to host two Summer Engineering Teaching Institutes for the next four years. The Southern California institute will be hosted by Pierce College, and the Northern California institute will be hosted by Cañada College. In addition to developing Tablet PC-enhanced instructional models for their courses, SETI participants will collaborate on developing an assessment plan to determine the effectiveness of the adopted instructional models. During the academic year, SETI participants will share the results of the changes they implemented in their courses through a Web Access website and regular online meetings. Additionally, further discussions and sharing of implementation results and best teaching practices will be done during the Teaching Techniques session of the California Engineering Liaison Council (CA ELC) meetings.

The Joint Engineering Program previously developed through ONESTEP will be expanded through the CALSTEP to help small community college engineering programs in California to increase their teaching productivity, as well as provide the opportunity for community colleges without engineering programs to offer core lower-division engineering courses to their students. As part of CALSTEP the Joint Engineering Program will be expanded to include additional community college engineering programs, and will allow engineering students from any of the participating institutions to take courses delivered through CCC Confer. This collaborative curriculum model will allow institutions to offer courses that could not be supported by individual engineering programs due to insufficient budget and limited student base. This will also allow students to complete all the necessary lower-division courses prior to transfer resulting in significant savings in time and resources, and an increase in the number of successful engineering transfer students. Students who take online courses through JEPs will receive academic support from their home institution in addition to the online academic support provided by the institution hosting the online course.

In addition to developing a set of online courses that are available to students from any of the JEP colleges, regular online and in-person meetings of JEP engineering faculty will also involve sharing of best practices that promote the recruitment, retention and success of community college engineering students. Cañada College will lead this collaborative effort by sharing its successes in implementing innovative STEM programs including the program activities that are proposed in the CALSTEP project.

The course descriptors and the Model Transfer Curricula developed for each of the major fields of engineering have been presented at the Community College Segment meetings of the CA ELC and have since been modified with additional input from California State University faculty representatives. They are currently being reviewed through a statewide vetting process. The adoption of common lower-division curriculum will not only simplify the articulation of courses with four-year universities, but will also make it easier for students to transfer earned college credits from one community college to another, or from one four-year institution to another. It will also simplify the articulation process by eliminating the need for course-to-course, institution-to-institution articulation agreements. With over 100 community colleges, 23 CSU campuses, and 10 UC campuses, a statewide articulation system would result in significant savings in time and resources.

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Appendix 1

Summary of Results from the Adoption Barriers Break-out Session

What are some of the barriers to adoption have you have encountered or anticipate?

- Time required to develop/debug materials
- Time required for grading (download, markup, upload assignments
- Keeping student engages, involved, and participating
- The time commitment for prepping a lecture takes away from other duties.
- The style of lecturing is confining and awkward (staying in one place)
- Poor attrition and engagement in online class
- Stylus/microphone, computer connection was most frustrating.

How did/will you overcome each of the barriers you identified above?

- Better time management
- Build on the material that was developed last year
- I don't know how to overcome time commitment. I am expected to do far more non-teaching college service than ever before.
- I hope that practice will help me overcome the confined feeling of lecturing on a small screen. I like to write on the board and draw on the board. The kinetic action of it helps me think in ways that "clicking" does.
- Next time I will have a mandatory orientation (FTF).
- Power point froze several times with tablet so I stopped using it and used pdf annotator instead. PPT to create presentation, PDF Annotator to deliver. Requires upfront effort to workout bugs, get technology figured out
- I kept on experimenting and practicing

For those who have adopted some of the SETI elements in their teaching, what would you have done differently?

Allowed more time prior to start of term to develop material

- Practice the ccc-confer sooner after the SETI
- More preparation time, if feasible. Release time for prep (or just release time from college committee meetings which are very time consuming.

What additional resources, training, support, etc. would you need to successfully implement technology in your courses?

- CCC confer, Eluminate, and the tablet PC are great tools and easy to use. The training provided through SETI has been sufficient to get me started. More detail wouldn't "stick" – I'd still have to relearn/refresh when going into production.
- I would like to explore use of tablets (such as Android w/pen input)
- The real resource I need is more time.