

An Integrated First-Year Experience at ECST (FYrE@ECST)

Dr. Gustavo B. Menezes, California State University, Los Angeles

Menezes is an Associate Professor in Civil Engineering Department at CalStateLA. Since becoming part of the faculty in 2009, Menezes has focused on improving student success and has participated in several teaching workshops, including one on "Excellence in Civil Engineering Education" and another in "Enhancing Student Success through a Model Introduction to Engineering Course." He is currently the PI of TUES project to revamp the sophomore-year experience at the college of engineering (esucceed.calstatela.edu) and the PI/Director of the First-Year Experience (FYrE) program at ECST. He has also developed an open access, web-based audience response system (educatools.com).

Dr. Deborah Won, California State University, Los Angeles

Deborah Won is an Associate Professor in Electrical and Computer Engineering at California State University, Los Angeles. Her specialization is in Biomedical Engineering and her scientific research area focuses on neuro-rehabilitative technology. Her educational research interests include use technology and active learning strategies to better engage students in the classroom as well as pedagogical and advisement approaches to closing the achievement gap for historically under-represented minority groups.

Dr. Mark Tufenkjian, California State University, Los Angeles

Dr. Tufenkjian is Chair of the Civil Engineering Department at Cal. State LA. His research interests include advanced geotechnical laboratory testing and in-situ testing of soft clay soils. His research has been funded by the Office of Naval Research (ONR) and the Department of Defense. He is currently the PI on a STEM grant from ONR to provide engineering students pathways to careers at Navy Labs in the southern California region.

Dr. Emily L. Allen, California State University, Los Angeles

Emily L. Allen, Ph.D., is Dean of the College of Engineering, Computer Science, and Technology at California State University, Los Angeles. She earned her BS in metallurgy and materials science from Columbia University, and her MS and PhD in materials science and engineering from Stanford University. She previously served as faculty, chair and Associate Dean at San Jose State University's College of Engineering. Dr. Allen believes in a collaborative, student-centered approach to research, education and academic administration and leadership. She currently serves on the ASEE Engineering Deans Council Executive Board, the ABET Academic Affairs Council, and chairs the ABET Task Force on Diversity and Inclusion.

Eva Schiorring, Research and Planning Group for California Community Colleges

Eva Schiorring has almost two decades of experience in research and evaluation and special knowledge about STEM education in community colleges and four-year institutions. Ms. Schiorring presently serves as the external evaluator for three NSF-funded projects that range in scope and focus from leadership development to service learning and experimentation with alternative delivery, including online lab courses. Ms. Schiorring is also evaluating a project that is part of the California State University system's new initiative to increase first year persistence in STEM. In 2014, Ms. Schiorring was one of the first participants in the NSF's Innovation-CORPS (I-CORPS), a two-month intensive training that uses an entrepreneurship model to teach participants to achieve scalable sustainability in NSF-funded projects. Past projects include evaluation of an NSF-funded project to improve advising for engineering students at a major state university in California. Ms. Schiorring is the author and co-author of numerous papers and served as project lead on a major study of transfer in engineering. Ms. Schiorring holds a Master's Degree in Public Policy from Harvard University.

Evidence-based Practice Paper: Integrated First-Year Experience at ECST (FYrE @ECST)

This complete evidence-based practice paper focuses on a first-year engineering program (FYrE@ECST) that integrates evidence-based interventions. In the United States, less than 40% of incoming engineering freshman will actually complete an engineering degree. At Cal State LA, where more than 65% are from underrepresented groups and the vast majority is first-generation college students, the retention and graduation rates are lower than the national average. For many years, faculty and staff at the College of Engineering, Computer Science, and Technology (ECST), Cal State LA, have implemented a number of evidence-based practices in the summer and first-year to help students transition into college and succeed in their engineering program. However, integration and systemization of these interventions have proven to be challenging. The summer bridge program (STEP) was launched in 2008, and comprises a 7-week math boot camp. It has been successful in enabling students to start their Fall term in a higher level math class, but was not enough of an intervention to guarantee future success in the engineering programs. The FYrE program, funded through a grant from the Helmsley Foundation, was implemented in the Fall 2015 to engage the students in the Cal State LA community from the outset, through a comprehensive first-year experience, which integrated a new first-year engineering and technology project-based course; physics and math supplemental instruction workshops led by peer-mentors; an inquiry-based math and physics workshop called *Mathemagics*; and a professional learning community (PLC) for faculty and staff involved in first-year programs in the college and across the university. Integration was further bolstered by cohorting student participants and through the development and use of a new advising tool known as the Golden Eagle Flight Plan (GEFP), which allows each student and his/her advisor(s) to keep track of the student's academic progress, career development and community engagement. The 32 FYrE students (treatment group) were compared to a concurrent, matched Control Group (CG-2) of 33 students from the same entering class who participated in the summer bridge program but none of the other FYrE interventions; and a historical Control Group (CG-3) with 33 students from the previous year who participated in the previous version of the summer bridge program. Students from all 3 groups started in Calculus I during their first Fall term, after participating in STEP. We compared academic outcomes (i.e. STEM grades and GPA) and progress towards major (number of math and physics courses completed) for treatment and control groups. Self-efficacy surveys, focus groups and interviews with students, faculty and staff were conducted to assess the various components of the program by exploring its critical aspects through the lenses of all parties involved. Initial results of assessment show very positive signs of improvement in terms of grades and progress-to-degree. In terms of progress-to-degree, 72% of the FYrE cohort completed 3 quarters of math in their first year. By comparison, 30% of CG2 and 27% of CG-3 students completed 3 quarters of math during their first year. For physics, about 60% of the FYrE cohort completed 2 quarters of physics, while fewer than 5% of CG2 and just over 15% of CG3 students completed 2 quarters of physics during their first year. In summary, the treatment group made more progress toward their major and achieved higher grades in math than students in the two comparison groups, putting them in a better position to complete their degrees.

Background

California State University, Los Angeles is located in East Los Angeles, in a county where 97.1% of residents are Hispanic, 26.8% live below the poverty line, and only 5.4% of adults over 25 hold a bachelor's degree. Over 60%, of our undergraduate population are first-generation college students, and most are first-generation engineers. About 40% of incoming engineering freshman join Cal State LA testing into remedial math, while the percentage of calculus-ready freshmen has traditionally been very low. The median household income of incoming students is \$36,600, with 33% of family income in the bottom income quintile. Cal State LA serves as a gateway to higher education for the youth in this population, and our College of Engineering, Computer Science, and Technology (ECST) serves as a gateway to STEM careers. Recently, Cal State LA was ranked 1st in the country in social mobility for propelling a higher percentage of students from the bottom fifth of income into the top fifth of U.S. earners¹. Cal State LA is a state comprehensive, non-Ph.D.-granting Title III, Hispanic Serving Institution (HSI) ranked 12th nationally in the number of STEM B.S. degrees awarded to Hispanics. Historically underrepresented minority (URM) groups comprise the majority of our ECST first-time freshman population (56-62% between the years of 2004-2012); however, the demographic spread of those earning degrees is disproportionate to our enrollment (Figure 1), with 6-year graduation rate fluctuating between 30 and 40%.

The challenges encountered by URM groups are usually rooted in the fact that students in these groups are often low-income first-generation college students, lacking academic preparedness. These challenges are often linked to a number of success traits that have often been connected in the literature to the odds of obtaining a college degree, such as academic mindset, grit, aspiration, study habits, family support, content knowledge, and reasoning and writing skills. Evidence shows that the “perfect” student, in the upper-bound with respect to all variables, with good study habits, strong family support, growth academic mindset, good content knowledge and strong reasoning and writing skills will be very successful in college²⁻⁶. Nevertheless, most students are able to graduate even when they do not have all these traits, as long as they have certain combinations of them. The problem arises from the fact that students from URM groups have not been equipped properly over their academic careers and they tend to be in the lower-bound when success variables are considered. Thus, the crucial questions that have driven most engineering research programs at URM-serving institutions are which success traits to focus on and what strategies can be used to equip students with these features and narrow the college readiness gap. Since incoming students are widely

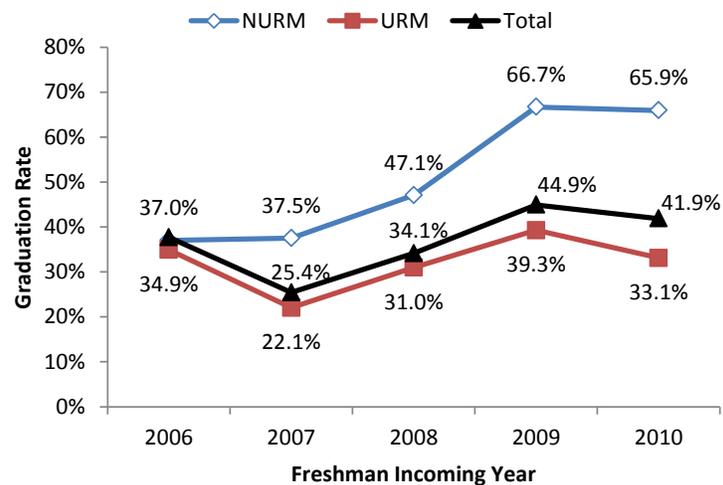


Figure 1. 6-year graduation rates for URM (Hispanic, Black and Native American) and Non-URM (White, Asian, Pacific Islander and International). It should be noted that 65% of our students comprise the URM group.

distributed through the parametric space with different abilities and needs, and each one responds differently to the many interventions that have been proposed and investigated, a unique set of interventions that works for all students has not been identified in the literature.

In the case of Cal State LA, the majority of engineering freshmen join their programs having tested into remedial or college algebra. For these students, ECST offers the Summer Transition to ECST Programs (STEP), which is a summer bridge program for incoming freshman. Summer bridges to college may be the most common intervention adopted by MSIs^{7,9} and their impact on URM groups continues to be investigated, with many institutions observing a positive impact on students in these groups¹⁰⁻¹³. STEP consists of two 3½-week rounds of daily (Monday through Thursday) intensive math targeted instruction. In between each round, students retake the math placement test and are allowed to move to more advanced math course during the second round if they pass these “exit tests”. In addition to math classes and workshops, STEP offers a series of workshops which attempt to help students prepare for the challenges of college work and success in composition courses and other activities, including an introduction to the College student orgs, to help students acclimate to the campus before the start of their first semester.

Although 90% of students move up at least one math level, there has been no significant improvement in graduation rates, especially when the URM group is considered, since STEP was first implemented in 2008. Currently, ECST is investigating an integrated approach, First-Year Experience at ECST (FYrE@ECST), in which engineering students are cohorted during the first and participate in the following interventions: a hands-on/project-based Introduction to Engineering course that helps students develop problem-solving and logical thinking as they are introduced to the engineering design process; *Mathemagics*, a program that helps students make connections between physical processes and mathematical principles; and peer-led supplemental instruction workshops for first-year Calculus and Physics. In addition to the student interventions, a professional learning community was established to bring together university faculty and staff who were involved in providing support to first-year students (i.e. advising, financial aid, academics, mental health, student life), and a comprehensive advising tool called the Golden-Eagle Flight Plan (GEFP) was developed and implemented (Figure 2). The paper describes each of FYrE interventions, presents a discussion on preliminary results and highlights some future plans for the program.

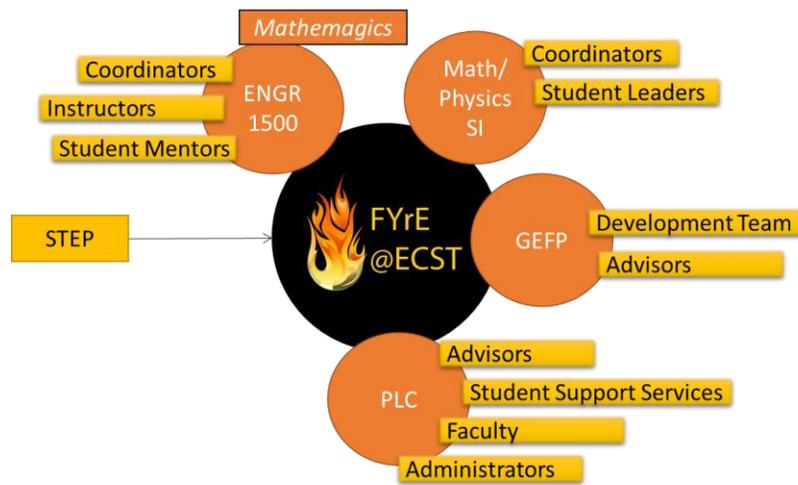


Figure 2. FYrE Interventions and programs

First-Year Experience (FYrE) @ ECST

In the Fall 15 semester, ECST piloted the first-year experience (FYrE) program with 32 (originally 33 but one student never started his/her program at Cal State LA) students that participated in STEP and then placed into Calculus I. The FYrE students (treatment group) were compared to a concurrent matched Control Group (CG-2) of students from the same entering class who received STEP, placed into Calculus I, but had no FYrE intervention. Comparisons were also made to a historical Control Group (CG-3), students from among the previous year's ECST Fall matriculating students. These students participated in the STEP program and placed into Calculus I at the end of their summer STEP program.

Figure 3 depicts a comparison among the FYrE and control groups of a student background characteristic that is of particularly high interest to the FYrE program. While FYrE had fewer first generation students than the Control Groups, half of FYrE students came from families where none of the parents had attended college. In addition, almost 20% of the FYrE cohort indicated their parents' extent of college attendance was unknown, which may imply that more of the FYrE cohort were also first generation college-goers. The components of FYrE program, which include Supplemental Instruction (SI) workshops for calculus and physics, a revamped introduction to engineering course, the *Mathematics* program, a new comprehensive advisement tool called Golden Eagle Flight Plan (GEFP) and a professional learning community (PLC) for faculty and staff directly involved in first year support programs, are based on widely investigated and accepted interventions, as described in details below.

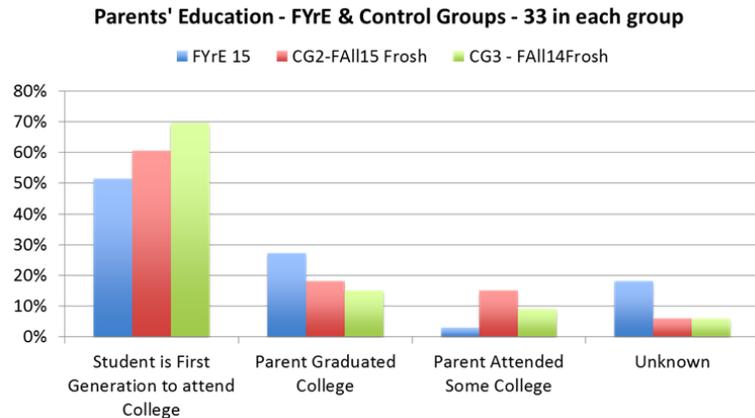


Figure 3. Comparison of Parents Educational Achievement: FYrE and Two Comparison Groups

Revamped Introduction to Engineering and Technology Course

All incoming ECST freshmen are required to take an introductory engineering, computer science, or technology course in their major. These courses serve as a gateway into the College and for years it was based on the "Introduction to Engineering Course" model by Dr. Ray Landis¹⁴ with focus on student development, including introduction to careers in their respective disciplines, academic success strategies, as well as University policies and procedures. However, many engineering colleges are taking advantage of the introductory gateway course to incorporate high impact practices, especially freshman-level hands-on engineering design projects¹⁵⁻²⁰. The University's 2016-17 quarter-to-semester conversion provided an opportunity to re-design this introductory course into an expanded Introduction to Engineering and Technology course (ENGR 1500). While most of Landis's model features have been kept, the course was expanded into a lecture plus laboratory project-based course centered on the science and engineering of our oceans, with the financial support of the Helmsley Foundation and a STEM grant

from the Office of Naval Research. The new course was piloted in the Fall 2015 and fully implemented in the Fall 2016 semester. The lectures include topics such as utilizing our oceans as a power and energy source, the impact of sea level rise and natural hazards on coastal infrastructure, and the use of remote-operated vehicles (ROV) and autonomous underwater vehicles in remote sensing, exploration, and search & rescue operations. The laboratory component was designed as hands-on utilizing the design, construction, and testing of a mini-ROV as the centerpiece (Figure 4). The weekly laboratory sessions, reinforced with topics introduced in the lecture, focus on introducing students to the engineering and science behind ROV design including fundamentals of buoyancy, propulsion, circuit design, navigation, tool usage and safety. An important outcome of the course is that students are learning engineering fundamentals by direct application before they have been more formally introduced through upper level technical coursework.

Specific hands-on activities include working with spreadsheets to carry out engineering computations, viscosity and buoyancy experiments, and construction of an electronic clock. Students are also introduced to additive manufacturing by modeling their ROV thruster propellers in Solid Works, altering the design, 3-D printing them, and physically testing them on their ROVs. A culminating end of term ROV competition takes place in the campus swimming pool (Figure 5). As part of their grade, student teams are required to develop and present a poster board about their ROV project.

Preliminary results from a post-course survey of the students indicate the course was very successful in increasing students' understanding of and commitment to the engineering and technology profession. During the focus group, students highlighted both the conventional aspects of ENGR1500 with comments like *"I'm a procrastinator. ENGR1500 really helped me with time management skills"* and *"I thought I would just come to class and start out slowly. Then they [Career Development Center guest speakers and ENGR1500 faculty] told us that you have to start thinking about finding mentors and internships and creating a resume..... from the very beginning"*, and the new aspects of the course, *"I realized that doing the physical work of engineering opens the mind,"* one student commented. One of his classmates added: *"I learned I really like engineering -- when we made stuff,"* and *"Engineering 1500 opens your mind to what an engineer does and helps you find out what you are getting into in engineering."*

Mathemagics

The *Mathemagics*²¹ program was introduced as lab modules for the pilot of the new Introduction to Engineering course. The goal of *Mathemagics* was to help students understand theoretical math concepts through physical applications. During *Mathemagics* sessions, students ran simple experiments and were asked questions which guided them to think critically and deepen their understanding of Calculus and Physics (Mechanics, Waves, and Electromagnetics) competencies (see Table 1 for covered topics). A think-pair-share mode of instruction was implemented to

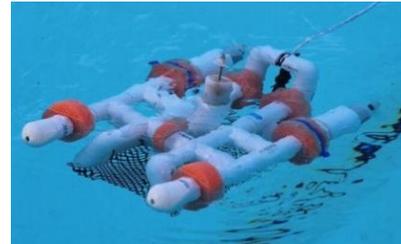


Figure 4. Remote-operated Sea Perch designed and built by engineering freshman in Introduction to Engineering and Technology Course from US Navy's Sea Perch (<http://www.seaperch.org>) kit



Figure 5. ROV competition

Table 1. Competencies reinforced in *Mathemagics* through related physical demonstrations of the competencies.

Math competency	Physics competency	Physical demonstration / experiment
Derivatives	Velocity / Acceleration / Newton's Laws of Motion	Falling ball / slow motion video app.
Vector components	Potential and kinetic energy; acceleration	Ball rolling off ramp to free fall vs. ball rolling off ramp onto ground: do they collide?
Vector sum	Gravitational force, momentum	Calculation of g from pendulum motion
Trigonometry	Optics	Estimation of building height using mirrors
Integration	Spring forces, Hooke's law	Estimation of spring constant

promote inquiry and discussion. Students worked in groups of 4 (Figure 6) to think about the questions they were being asked, carried out experiments to answer the questions, and then shared what they learned with the class. In one of the Modules, for example, students were asked to record a slow motion video (using a phone app) of a falling tennis ball. Then, the groups were asked to use data from the slow motion video to plot position vs time for the tennis ball in big graphing posters placed on the walls around the room (Figure 6). After students had developed the plots, we regrouped and started a reflective discussion. Students were posed with questions such as: can we determine if the velocity is constant or not by looking at the plot? How would a constant velocity plot look like? What feature in the plot indicates that the initial velocity is zero? During the process, students were able to relate the slope of the plotted curve to the velocity of the ball by computing the average velocity between two points and realizing that the instantaneous velocity is the slope of the trajectory function. Also, it became clear that the zero slope of the curve at time zero represented the initial velocity of the ball. Afterwards, additional questions led students to understand that the smaller the time interval used, the closer the computed average velocity slope was to the actual instantaneous velocity slope at a given point. At the end, it was clear that when change in time was infinitely small, the computed velocity slope would be the actual instantaneous velocity at a given point. Thus, the concept of derivatives was introduced. Concurrently, students were taking Calculus I, which covers derivatives, so the connection between the mathematical theory and the physical process made a lot of sense to most students. Student's feedback on *Mathemagics* was very positive. During the focus group, students noted that they had to engage in "lots of thinking." "They [the *Mathemagics* instructors] don't just tell us the equations and how to memorize them, but give them meaning in a way that relates to real life." Another student echoed this point noting that "They [the *Mathemagics* instructors] do not give us the answers so we have to figure things out on our own." *Mathemagics* modules (Figure 7) will serve as a foundation for a new pre-physics course for engineering students to be piloted in the Fall 2017 semester.



Figure 6. *Mathemagics* workshops

Module 1: Derivatives

Objective: Help students better understand the concept of derivatives and how they are used to describe physical processes in science and engineering.

Main Ideas: Although many of these concepts, such as time, displacement, velocity, acceleration, are used on a daily basis, often students have a hard time applying them in engineering problems, because it is often difficult to describe these concepts through mathematics. By the end of this module students should have a better understanding of the concepts of magnitude and direction (vectors) applied to these basic concepts. Although the problems are clearly defined below, an inquiry-based approach is recommended, where students are asked to solve the problem, and guided through the process. i.e.: How would you find the velocity from displacement plot?

Topics Covered: Derivatives, Time, Speed, Acceleration,

Related Competencies: Calculus - Derivatives, Physics – Kinematics

Units: Metric

Materials: Tennis Ball, Smart phone with Slow Motion Video App, Measuring Tape

Activity: Plotting Displacement vs. Time of a falling Ball



Part A: Brief Review of Motion Equation

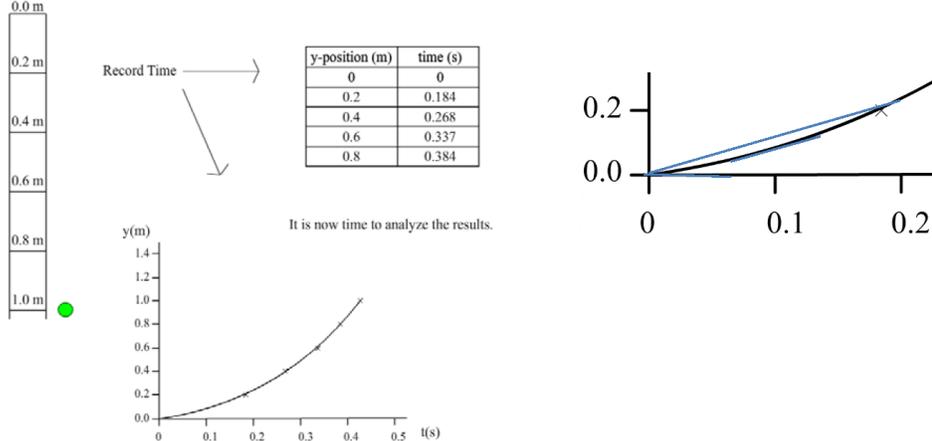
Part A involves a conceptual derivation of the motion equation in its most basic form. This is just meant to be a “warm-up” problem so they are ready for Part B. They should be able to understand that motion can be described by a mathematical function.

Procedure: Question to Students: what is the position of a car that travels with a speed of 70 MPH after one hour. Many students will answer 70 Miles, but it is important to realize that 70 Miles is only the displacement and the initial position must be known if one is seeking the final position. After a brief discussion, motion equation can be set: $x = x_0 + vt$.



Part B Falling Ball Experiment

Ask students to setup the falling ball experiment, drop the ball from position zero and use the Slow Motion Video app to record as the ball falls. Students should then plot the position vs. elapsed time.



Inquiry/ Analysis:

- Can we determine if the velocity is constant or not by looking at the plot?
- How would a constant velocity plot look like?
- What feature in the plot indicates that the initial velocity is zero?
- Determine the velocity from 0.0 to 0.2 m. If the initial velocity is clearly zero, what the calculated velocity means? Is that the velocity at 0.2m?

$$v \approx \frac{x_f - x_i}{t_f - t_i} \text{ also described as } v \approx \frac{\Delta x}{\Delta t}$$

- Compare the computed velocity slope, with the slope of the actual curve at zero and at 0.2m.
- Why is the velocity increasing?
- How can I make the computed velocity (slope), be closer to the actual velocity at 0.2m?
- What happens to the slope when Δt becomes smaller and smaller?

$$v = \frac{\Delta x}{\Delta t} \underset{\Delta t \rightarrow 0}{=} \frac{dx}{dt}$$

Figure 7. Sample module of *Mathemagics* workshop

Supplemental Instruction (SI) Workshops

FYrE students were enrolled in Supplemental Instruction (SI) academic support workshops (Figure 8) for Calculus and Physics during their first year. The peer-led workshops were based on the UMKC SI model²², although FYrE participants were required to participate, so attendance was not voluntary as recommended by the model. In the past, some similar support workshops in the college had very low attendance, so the FYrE leadership team decided to make it a requirement. SI leaders received training at the beginning of the semester and participated in weekly meetings with the SI supervisor to go through proposed activities. On average, workshops had 8 students per mentor and met twice a week for an hour and fifteen minutes during the semester (Figure 8). Students learned how to approach and solve problems, how to study effectively and help each other. The community building of SI and FYrE interventions was a positive aspect of the program, as highlighted by participants *“We became friends and got closer - like before the midterm we studied together for 2-3 hours and that was really good.”*; *“it is interesting to see how people think in different ways about how to do projects and the different thinking process different people have.”*



Figure 8. Supplemental Instruction Workshops

Golden Eagle Flight Plan (GEFP)

The Golden Eagle Flight Plan (GEFP) is a web-based self-advisement tool designed by FYrE leadership team with the help of staff and faculty advisors and implemented by Sun et al.²³. GEFP allows students to set goals and steps needed to achieve them and enable students and advisors to keep track of these milestones towards a successful college career. Goals and milestones form a matrix divided into stages of their career (i.e., from pre-frosh through senior level) and into “runways”, which we categorized as 1) academic performance; 2) career preparation; and 3) leadership & community engagement (Figure 9). Although GEFP provides guidance to students and advisors primarily by reminding them of appropriate next steps in their journey through the program, students have to take the responsibility over their academic careers and make sure they are ready for their professional lives when they graduate.

The GEFP Online software system was designed to meet multiple objectives, including (i) students view their own flight plans by logging into an online dashboard system using the same account information as their campus web login ID and password; (ii) each student inherits a major-specific template; (iii) advisors are able to view any student’s plan using a search function; (iv) students can keep track of milestones they have accomplished; (v) students and advisors can communicate with each other through comments that can be saved for each milestone as well as for the overall plan for each student; (vi) GEFP Online also serves as an informational resource, as most milestones have hypertext links to a webpage that either provides more information about the milestone or actually assists the student in carrying out the milestone (e.g. a registration link for an event, a link to make an appointment, etc.)

MyGoldenEagle Flight Plan 2.0 - CE Semester (Fall 2016) Published ↻			
Major: Civil Engineering			
	Academic Performance	Career Preparation	Leadership & Community Engagement
Pre-college (pre-flight checklist)	<input type="checkbox"/> Attend STEP <input type="checkbox"/> Algebra (before Yr 1) <input type="checkbox"/> Pre-calculus (before Yr 1) <input type="checkbox"/> Take EPT <input type="checkbox"/> Take ELM <input type="checkbox"/> Attend ECST Freshman Orientation. <input type="checkbox"/> Submit official transcript <input type="checkbox"/> Submit official test scores (e.g., SAT, ACT, APs)	<input type="checkbox"/> Apply for Financial Aid <input type="checkbox"/> Apply for Scholarships	<input type="checkbox"/> Make a list of questions to ask during orientation and ask them
Freshman (take-off)	<input type="checkbox"/> Math 2110 (Calc I) <input type="checkbox"/> Math 2120 (Calc II) <input type="checkbox"/> Phys 2100 (Mechanics) <input type="checkbox"/> ENGR 1500: ENGR 150 Sec. 03 + ENGR 154 Sec. 30 OR 31 <input type="checkbox"/> Attend Supplemental Instruction (S.I.) or Math Academic Excellence Workshops (AEW) (i.e. ENGR 154 workshops) <input type="checkbox"/> Attend Physics SI or AEW (i.e. ENGR 154 workshops) <input type="checkbox"/> Get started on all other lower division major requirements (100/200-level CE courses) <input type="checkbox"/> Sign up for BOOST! <input type="checkbox"/> Go to office hours after 1st assignment in every class <input type="checkbox"/> Keep track of your grades / progress in	<input type="checkbox"/> Visit Career Center and find out what services they offer <input type="checkbox"/> Take career self-assessment / personality assessment test. A couple examples are given below: <input type="text" value="Select a test"/> <input type="button" value="Go"/> <input type="checkbox"/> Identify at least on type of career that you might want to pursue. Start by exploring the different majors in ECST. Create a comment to make note of which career you want to pursue. <input type="text" value="Select a discipline"/> <input type="button" value="Go"/> <input type="checkbox"/> Register for Eagle ijobs <input type="checkbox"/> Pathways to Success Workshop Series - Career Development <input type="checkbox"/> Apply for Financial Aid	<input type="checkbox"/> Find out about ECST student organizations at ECST week <input type="checkbox"/> Join at least one student organization and actively participate <input type="checkbox"/> Share with someone in your community about what you are learning in school <input type="checkbox"/> Participate in time management workshop (Tutorial Center) <input type="checkbox"/> Attend Pathways to Success Workshop Series - Leadership Development <input type="checkbox"/> Attend the Student-Faculty Breakfast <input type="checkbox"/> Attend Leadership Convocation <input type="checkbox"/> Volunteer at one or more outreach events: <ul style="list-style-type: none"> • ECST Open House/Boeing Day • MESA Days • Science Bowl

Figure 9. Screenshot of GEFP Web-based advisement tool

Based on usage logs recorded in the period, about 58% of the students visited the GEFP website during the first semester. The team has recently developed Android and iOS apps for GEFP with a feature that will enable advisors to push messages into students' cellphones with reminders and advisement-related messages. With the new feature in place we hope students will use GEFP more often. Students were asked in a survey "How much do you agree with the following statement regarding the Golden Eagle Flight Plan? I have a better understanding of what I need to become a successful engineer by using the GEFP." Survey results indicated that 79% of the students agreed or strongly agreed that the GEFP helped them have a better understanding of what they need to become a successful engineer; 21% responded that they neither agreed nor disagreed. More complete survey results and analysis of the GEFP as an advising tool can be found in Sun et al. ²³.

Professional Learning Community Meetings

Although all the departments and programs within the university directly or indirectly contribute to student success, they often operate autonomously, each with its own system, budget, and approaches, which may not be clear to people in other units. This siloed approach usually creates unnecessary bureaucratic procedures and inefficacy on campus. In Spring 2015, prior to the launch of the FYrE program, the leadership team implemented a Professional Learning Community (PLC) (Figure 10). The purpose of the PLC was to spawn collaborations across campus which would enable and enhance student success programs, including FYrE. FYrE was described at the first meeting in hopes that ensuing discussion would include how to apply various tools and approaches to FYrE in order to improve the program and even expand the initiative to other colleges.



Figure 10 – Professional Learning Community Meetings

The PLC communicated through an online forum and primarily through monthly meetings, with 10-25 participants comprised of faculty representing Chemistry, Math, Electrical Engineering, Mechanical Engineering, Civil Engineering, Technology Departments, Academic Senate and administrators and staff from the Registrar’s Office, Financial Aid, University Advisement, Educational Opportunity Program (EOP), ECST Advisement Center, MESA Schools Program (MSP), Institutional Research, and Enrollment Management Services. The meetings were conducted over a span of 14 months and the general format for each meeting consisted of someone from a different department and/or division presenting on a particular topic of interest in designing and running student success initiatives, followed by an open-ended discussion. Topics included peer-facilitated learning, web-based advising tools and the use of technology more generally in career development and advisement, the transfer evaluation process, how to break down barriers to collaboration, and the growth mindset (as defined and described by psychologist Carol Dweck). A quick online reflections survey was made available to the PLC after each meeting, and summary notes of the discussions were posted on the PLC forum.

1. *What is the main reason you came to the meeting today?*
2. *What is one thing new you learned from today's meeting? (if nothing, please write N/A)*
3. *What is one outcome you hope will result from participating in this PLC?*

Responses to Q1 included: “meeting other individuals on campus who have the same shared goal [:] Student Success”; “being involved in a community of learners”; “I’m aware of the project and components but am interested in being part of the PLC in building this program and in building collaborations across campus”.

Responses to #2 included: “I didn't know there were so many program in this campus that involve several other departments.”; “I learned of the wide variety of programs already in place to enhance the first year experience of our students”; “I met the director of First Year Experience and learned a little bit more about their program”; “Engineering has engaged faculty interested in improving the first year experience for students!”

Responses to Q3 included: “One of my hopes is that the PLC will be the catalyst of many collaborative efforts on campus with various entities will start working together to meet the common goal which is to serve our students in a more efficient and collaborative manner.”; “That I can learn what best helps our students and can coordinate a concerted effort in my own college to institute the "best practices" for facilitating student success”; “Getting all of the folks involved in these programs together to discuss what is being done should result in good coordination of all of the efforts to ensure student success.” From the comments made directly to

the leadership team, it was clear that people got to know and understand a lot of procedures, and were seeing people opened the door for interdepartmental collaborations.

The attendance at PLC meetings was only tracked for the first 6 meetings (Figure 11), as FYrE underwent a change in project coordinator, and all the roles were not transferred to the new project coordinator. However, the attendance did trail off after the 6th meeting, and typically the subsequent meetings had 10-15 attendees. During the fourteen months that the PLC was meeting, the campus was also undergoing preparations for quarter-to-semester conversion. The increase in effort required for the Q2S conversion right around the end of 2015/early 2016 may have contributed to a decline in attendance, but also, one goal of the PLC was not attained.

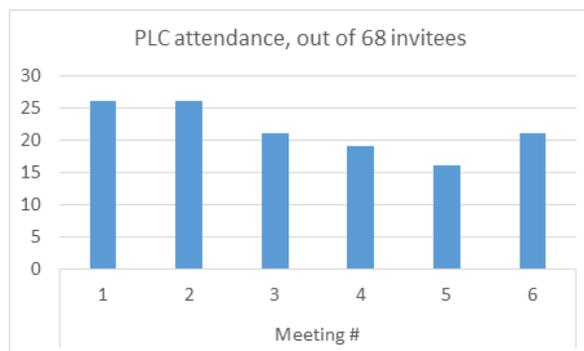


Figure 11 – Professional Learning Community Meeting attendance

The FYrE leadership team tried to offer minigrants, named FYrE Starter Awards, to encourage interdepartmental teams to propose and work on starting collaborative efforts toward implementing some of the ideas discussed at the meetings. No proposals were ever received, and it seemed clear that although the desire and goodwill to collaborate existed quite strongly amongst the PLC members, no one seemed to have the time or energy to devote to such new collaborations. On the other hand, even though no formal feedback was obtained, many reported informally to the program director that they understood other departments better, and that putting faces to names helped them to work better with others across campus. Thus, while the PLC is in some way formally disbanded, the leadership team felt that increased trust between divisions was promoted which would lead to ongoing collaborations around campus. In fact, many of the offices whose staff attended the PLC have now been moved from Student Affairs into Academic Affairs, and the increased knowledge and trust between faculty and staff has resulted in numerous improvements in business practices for student success on campus.

Results and Considerations

Academic Performance

After first year, retention for all 3 groups was about 80% (Figure 12). However, as indicated in Figure 13, 72% of FYrE completed 3 quarters of math in their first year of ECST, while only 30% of CG2 and 27% of CG3 students completed 3 quarters of math during their first year of ECST. About 60% of FYrE completed 2 terms of physics in their first year (Figure 14). By comparison, fewer than 5% of CG2 and just over 15% of CG3 students completed 2 terms of physics during their first year at ECST. FYrE students both made more pro-

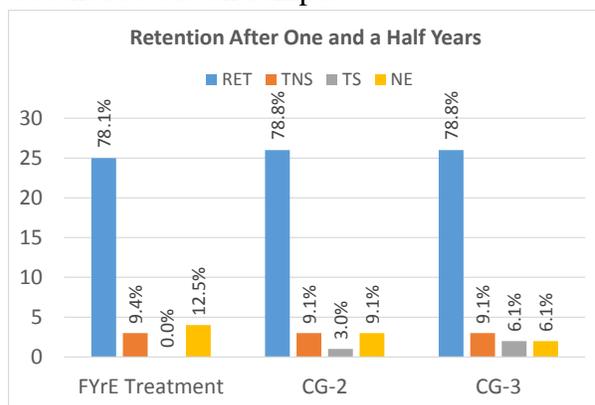


Figure 12. Retention based on 2nd year enrollement data (RET – Retained; TNS – Transferred to Non-STEM Major; TS – Transferred to STEM Major; NE – Not Enrolled)

gress toward their major and achieved higher grades in math than students in the two comparison groups. The math average GPA for FYrE students at the end of the first year was 2.9 (Figure 15), compared to 2.2 and 2.45 for CG-2 and CG-3, respectively. Although the FYrE students' physics GPA appears lower than that of the control groups, Figure 13 shows that fewer control group students completed physics at all. The comparison of physics grades may not be meaningful, if only the most advanced students from control groups took physics in the first year.

Nevertheless the poor physics GPA for FYrE has engendered an additional future intervention (discussed below). In terms of overall average STEM GPA (defined as GPA calculated with grades only in STEM-related courses), the FYrE students slightly outperformed the CG3 control group, which took many fewer STEM courses, and did significantly better than the CG2 students, who also took fewer STEM courses. As depicted in Figure 16, FYrE also had fewer students who completed their first year at ECST with STEM GPAs under 2.0. Less than one-fourth of FYrE students fell into this category compared to more than 40% of CG2 students and over 30% of CG3 students [Note that GPA data was calculated only for those who remained in ECST majors at the end of the first year]. In summary, FYrE students made more progress and achieved better grades than students in the two comparison groups.

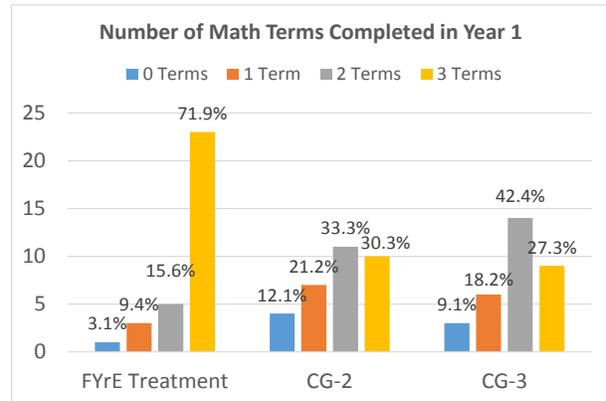


Figure 13. Progress in Math, FYrE vs Comparison Groups

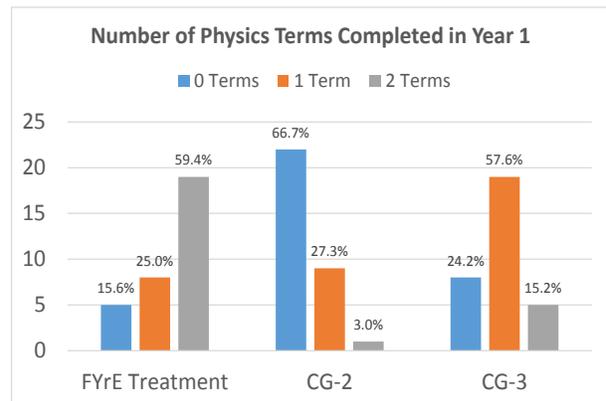


Figure 14. Progress in Physics, FYrE vs Comparison Groups

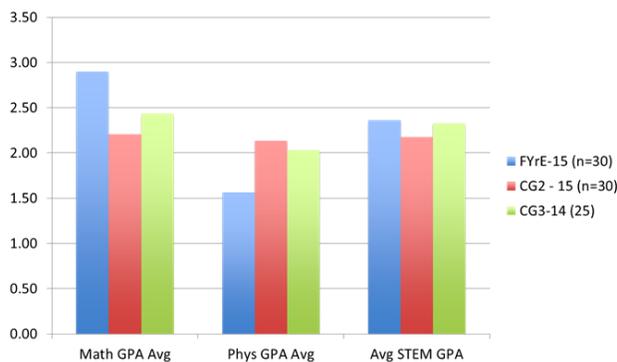


Figure 15. Major GPA: FYrE vs. Comparison Groups

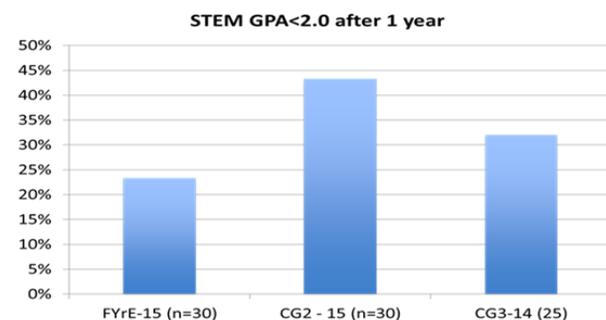


Figure 16. Major GPA below 2.0; FYrE vs. Comparison Groups

Assessment Survey

A survey was administered in Fall 2015 to all incoming ECST students and in the Summer 2016 to the same students beginning their sophomore year. The surveys included the Marra et al.²⁴ validated engineering self-efficacy questions to which ECST added questions aimed at documenting and creating a base line for students' engagement with ECST and with each other inside and outside of the classroom. Preliminary analysis of the survey found that students draw great support from each other: *"My peers have helped me to study and lend me their books so I could save a little money in courses"*; *"I got to meet a lot of people who are now good friends which helps with dealing with stress from classes"*. Another key finding is that students need help from faculty and support professionals to identify and engage with the range of supports that are available to them, including opportunities to connect with other students: *"The engineering workshops helped a lot because it allowed us to solve problems, ask questions, and work in groups in order to be on top of our subjects"*. Further results on self-efficacy questions will be made available in a future publication.

Conclusion and Future Work

The paper presents the details of the First Year Experience (FYrE@ECST) program, piloted at Cal State LA to support engineering student success. During FYrE, 32 engineering students were cohorted and participated in a number of interventions, including a revamped Intro to Engineering course, *Mathemagics*, Supplemental Instruction (SI) workshops for Math and Physics courses and received advising using a newly developed web-based tool (Golden Eagle Flight Plan – GEFP). Both progress-to-degree data, evaluated by comparing the number of math and physics terms completed, and GPA shows that FYrE treatment group performed significantly better than control groups, which is an indication that FYrE interventions were effective. Nevertheless, treatment group GPA in physics was lower than desired. Thus, a new pre-physics course, based on *Mathemagics* modules, will be piloted in first semester of the program in Fall 2017. The new course will cover approximately half of the content of the Physics I (mechanics) course and will focus on connecting physical processes (hands-on activities) to the mathematical principles used to describe them. With the new course, students should be better prepared to succeed in the Physics sequence and mechanics-based engineering courses. Regarding GEFP, although students seem to like the interface, they have not used the tool to the extent that was expected. We are currently working with advisors and plan on making GEFP the advisement tool for all students in the college. Also, with the new feature to push notification to mobile we expect the tool to be used more frequently by students. Finally, this past year we doubled the size of the FYrE cohort and fully implemented the new Intro to Engineering course to all freshman students. We hope to report additional findings in a future publication.

Acknowledgements

This work was only made possible due to the contributions of many individuals. The authors would like to thank Dr. Mauricio Castillo, Dr. Mohsen Eshraghi, and Dr. Arash Jamehbozorg, faculty coordinators of new Introduction to Engineering Course; Dr. Zanj Avery and Dr. Sharri Kornblum, Physics/Math Supplemental Instruction Coordinators; Dr. Adel Sharif, faculty co-

coordinator of *Mathemagics* program; Frances Hidalgo, Director of Student Success; Evelyn Crosby, T. Fox, Candi Marsh and Rudy Ramirez, advisors from the ECST Success Center; Dr. Chengyu Sun, developer of GEFP; Dr. Jane Dong, ECST Associate Dean; and Dr. Michele Dunbar, Associate Director of Institutional Research. This work was partially funded by the CSU STEM Collaborative grant awarded by the Leona M. and Harry B. Helmsley Charitable Trust and by the Office of Naval Research (ONR) through a Naval STEM Grant (Contract Number N00014-15-1-2434; PI: Mark Tufenkjian). The assistance of Dr. Michael Simpson, Director of Education and Workforce for ONR is greatly appreciated. Finally, the GEFP is based on an original idea from Francis Castillo, Director of Advising at SJSU.

References

1. R Chetty, J. N. Friedman, E. Saez, N. Turner, and D. Yagan, "Mobility Report Cards: The Role of Colleges in Intergenerational Mobility," <http://www.equality-of-opportunity.org/>
2. Rawson K, Stahovich T. Predicting course performance from homework habits. . 2013.
3. Lerner AA. Gritty students: The effect of perseverance on retention for traditional and nontraditional students. . 2013.
4. Jaeger B, Freeman S, Whalen R, Payne R. Successful students: Smart or tough? . 2010.
5. Orr M, Benson L, Ohland M, Biggers S. Student study habits and their effectiveness in an integrated statics and dynamics class. . 2008.
6. Bradley S, Bradley W. Increasing retention by incorporating time management and study skills into a freshman engineering course. . 2006:Dassault Systemes; HP; Lockheed Martin; IBM; Microsoft; et al.
7. Ackermann SP. The benefits of summer bridge programs for underrepresented and low-income transfer students. *Community Junior College Research Quarterly of Research and Practice*. 1991;15(2):211-224. <http://dx.doi.org/10.1080/0361697910150209>. doi: 10.1080/0361697910150209.
8. Reisel JR, Rineck L, Jablonski M, Munson E, Hosseini H. Evaluation of the impacts of math course placement improvement achieved through a summer bridge program. . 2011.
9. Papadopoulos C, Reisel J. Do students in summer bridge programs successfully improve math placement and persist? A meta-analysis. . 2008.
10. Hudspeth MC, Aldrich JW. Summer bridge to engineering. . 2000:5385-5394.
11. Lee WC, Seimetz CN, Amelink CT. Examining the transition to engineering: A multi-case study of six diverse summer bridge program participants. . 2014:Dassault Systemes (DS); et al.; Kaplan; National Instruments; NCEES; Quanser.
12. Nagchaudhuri A, Singh G. Summer engineering bridge program at the university of maryland eastern shore: Objectives and enrichment activities. . 2001:9213-9223.
13. Persaud A, Freeman AL. A model for underrepresented minority students' success in engineering: The PREF summer bridge program. . 2005:10453-10460.
14. Landis RB, Prather EN. Enhancing engineering student success: Working with students to change their attitudes. . 1998:8pp-8pp.

15. Claveau D. A multidisciplinary design project for an introduction to engineering course. . 2014:74-77. <http://dx.doi.org/10.1109/IEDEC.2014.6784684>. doi: 10.1109/IEDEC.2014.6784684.
16. Husted S, Gutierrez JV, Ramirez-Corona N, Lopez-Malo A, Palou E. Multidimensional assessment of creativity in an introduction to engineering design course. . 2014:Dassault Systemes (DS); et al.; Kaplan; National Instruments; NCEES; Quanser.
17. Tian JE. A design approach in an introduction to engineering course. . 2014:Dassault Systemes (DS); et al.; Kaplan; National Instruments; NCEES; Quanser.
18. Jassemnejad B, StJohn ST, Lemley EC, Rada K, Orozco JC. Laboratory and design experiences in the introduction to engineering course at an engineering and physics department. . 2013.
19. Gerhart AL, Fletcher RW. Project-based learning and design experiences in introduction to engineering courses - assessing an incremental introduction of engineering skills. . 2011.
20. Karam LJ, Mounsef N. Increasing retention through introduction to engineering design. . 2011:186-191. <http://dx.doi.org/10.1109/DSP-SPE.2011.5739209>. doi: 10.1109/DSP-SPE.2011.5739209.
21. Sharif AA, Menezes GB, Schlemmer LT, Won DS. Discovering the magic of mathematics: Mathemagics. . 2016.
22. Martin D, Arendale D. *Supplemental Instruction: Improving First-Year Student Success in High-Risk Courses*, ; *Monograph Series no.7*; South Carolina University: Columbia, SC, 1992..ED354839.
23. Sun C, Won D, Allen E. L, Gadhia H. Golden eagle flight plan online: A web-based advisement tool to facilitate developmental advising. American Society of Engineering Education Annual Meeting, New Orleans, LA. 2016.
24. Marra RM, Rodgers KA, Shen D, Bogue B. Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self-efficacy. *J Eng Educ*. 2009;98(1):27-38.