The Dual Enrollment Math Bridge (DE Math Bridge) Project

A proposal for the Education Innovation and Research Program's Early Phase Grant

Submission by: College Bridge, a 501(c)(3) non-profit organization

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A. Significance

College Bridge, a California-based non-profit educational organization established in 2011, is applying for an Early-phase grant in response to *AP1: Demonstrates a Rationale, AP2: Field-Initiated Innovations - General, AP3: Promoting Equity in Student Access to Educational Resources and Opportunities: STEM, CP1: Promoting Equity and Adequacy in Student Access to Educational Resources and Opportunities, and CP2: Addressing the Impact of COVID-19 on Students, Educators, and Faculty.* Our proposed **Dual Enrollment Math Bridge (DE Math Bridge)** project is based on the evolution of a series of longitudinal research/practice projects College Bridge has successfully developed, implemented, and evaluated since 2013.

DE Math Bridge: A promising new strategy building on existing, proven strategies

DE Math Bridge provides equitable access to rigorous college-level math courses for high school students who otherwise lack such access due to under-preparation or a lack of availability. Students who are deemed underprepared for college math are provided access to college-level dual-enrollment math courses with built-in systems of support. The courses are provided at no cost to students, on their high school campus, during the regular school day. To date, 84% (N = 1,889) of underprepared high school students who participated in earlier iterations of DE Math Bridge passed the college math courses. In addition to earning college math credit, students cite the experience of a college class while in high school as instrumental in preparing them for their transition to college. Additional promising outcomes have emerged, such as 20% (n=284) of DE Math Bridge alumni pursuing a STEM major in college after experiencing a DE Math Bridge Statistics course, and DE Math Bridge students' college persistence rates outperforming national averages (Cevallos et al., 2022).

DE Math Bridge extends beyond the students served, having a transformational effect on high school faculty, staff, and the school's math program. DE Bridge impacts administrators, counselors, and teachers as they learn to align programs and advising to the college's math placement metrics. Transformation also happens systemically, as DE Bridge creates pathways at the high school that align to students' post-secondary goals. The following sections detail the evolution of the need, project design, goals, lessons learned, and student outcomes.

Setting the Stage: National Significance – The Big Picture.

Access to a college education is critical both for improving people's quality of life and society as a whole. People graduating with a bachelor's degree earn wages 71% to 136% higher than those of high school graduates (Bartik & Herschbein, 2018). Society benefits from a college-educated population by enjoying a more robust economy; stronger civic engagement; and lower levels of crime, poverty, and health care costs (Baum, Ma, & Payea, 2010). Unfortunately, college graduation rates for low-income, minority students are decreasing in comparison to those of white, non-Hispanic students even though students of color are the nation's fastest growing demographic (US Census Bureau, 2019). Inequitable outcomes in high school mathematics for under-represented students lead to further inequitable outcomes in college (Page & Scott-Clayton, 2016). Specifically, of the 1.7 million students nationwide who are placed in remedial college classes annually (National Center for Educational Statistics, 2010), less than one-third will graduate within six years (Jones, et al., 2012). Students who do complete their college degrees are adversely affected by remediation through the accumulation of greater debt, spending more time in college, and delaying their entrance into the workforce (Tierney et al, 2011).

Setting the Stage: State Significance – History of Inequitable Attainment and Achievement.

The California State Universities (CSUs), the nation's largest public university system, has grappled with remediation for decades despite the CSU admitting the top third of California's high school graduates (The California State University, 2019). In the early 2000's the CSU math remediation steadily hovered near 35%. In 2004, the CSU launched the Early Assessment Program (EAP) in an effort to lower remediation rates.

The EAP was a test high school juniors enrolled in Algebra II or higher could take to demonstrate college math readiness. *Table 1* shows the inequitable attainment and achievement rates on the EAP for students based on race in 2010. The outcomes for Black and Hispanic students had remained unchanged since the inception of the EAP in 2004.

Table 1. Attainment and Achievement Rate of EAP for California's 11th Graders in 2010

Race	Juniors in Algebra II or Higher who took the EAP (Attainment)	College Math Readiness Rate (passing EAP score) (Achievement)
Hispanic	39% (n = 88,677)	6% (n = 5,321)
White	54% (n = 77,306)	17% (n = 13,142)
Asian	78% (n = 34,193)	35% (n = 11,968)
Black	34% (n = 12,322)	4% (n = 493)

In 2011, California launched a new state assessment called the California Assessment of Student Performance and Progress (CAASPP), mandated for all juniors. Beginning in 2013, the EAP abandoned its previous test and accepted a Level 4 CAASPP score as a qualifying metric for College Math Readiness. *Table 2* shows outcomes for all juniors in 2018.

Table 2: College Math Readiness Rates via the EAP, by Race and Income (2018)

2018 EAP Data (Level 4 CAASPP)	Number of Juniors*	College Math Ready
All Students	437,883	13% (56,443)
Race		
Hispanic	232,433	5% (11,622)
White	104,873	19% (19,926)
Asian	42,593	44% (18,741)
Black	24,015	3% (720)
Economic Status		
Low-Income	252,960	6% (15,304)
NOT Low-income	184,923	22% (41,164)
*Only juniors with test scores are included in the calculation. Source: https://caaspp.cde.ca.gov/sb2018/Search		

The change to CAASPP addressed the attainment issue, but achievement gaps persisted. Achievement rates for white and Asian students climbed over the years while Black, Hispanic, and low-income students' scores remained stagnant from 2013-2018.

During this time, math remediation also negatively impacted CCC graduation rates. Consistently, nearly 80% of CCC students placed in remedial math courses with only 40% completing college within six years. In contrast, of the approximate 20% who matriculated math-ready, 72% completed college within six years. When the data were disaggregated for low-income and minority students, 92% arrived unprepared, with only 33% of completing within six years (California Community Colleges, 2018; Rodriguez, Cuellar-Mejia, & Johnson, 2018).

DE Math Bridge Phase One. Initial "SLAM" Pilot (Fall 2013 – Spring 2016).

The initial intervention, originally called the South Los Angeles Math (SLAM) Project, was born from [redacted]' dissertation, *Best Practices of P-20 Partnerships for Increasing College Access and Persistence for Under-Represented Students* (Cevallos, 2013). Examining the issue from a systemic perspective, [redacted] studied intersegmental partnerships addressing the remediation dilemma through academic alignment. The partnerships provided high school seniors with remedial college courses with the promise that successful completion would allow enrollment directly into transfer-level courses upon matriculation to the partner college. [redacted]' found the following challenges in the programs: (1) the interventions provided basic skills content and high school seniors were ashamed to be in the classes, (2) the remedial classes depended on support from math or writing labs that did not exist on the high school campus, (3) high school faculty had no freedom to adjust the curriculum to meet student needs, (4) college faculty made curricular decisions without involvement from the high school teachers, (5) some interventions were only accessible after school thus limiting

accessibility for the neediest students, and (6) students only benefitted if they attended the partner college. [redacted] sought to develop a new model to contrast these challenges.

The SLAM project was developed in partnership with CSU, Los Angeles (CSULA) as an innovative intervention to decrease their math remediation rate, which stood at 68% in 2012. The target schools were LAUSD's lowest performing high schools in Central and East Los Angeles. The overarching purpose of SLAM was to learn if dual enrollment was an effective strategy to close the college attainment and achievement gaps for underprepared, minority, low-income students. The goal was a 70% college math pass rate; the strategy was to bridge the high school and university curricula and leverage the students' senior year as a catalyst for college success.

CSULA chose Quantitative Reasoning with Statistics for the pilot. Instead of the typical basic skills remediation, SLAM gave underprepared students access to a college-level math course with embedded support for free, on the high school campus, during the regular school day. The program employed a co-teaching model where a college professor taught the college content three days per week in collaboration with a high school teacher who provided intervention two days per week. Students who earned a C or higher earned CSU college credit. SLAM was funded by the Michael & Susan Dell Foundation (MSDF) ([redacted]), CSULA ([redacted]), and LAUSD ([redacted]).

The pilot spanned three years with 165 students from three urban LAUSD high schools participating in the project. The average SLAM pass rate was 77%, compared with an average of 71% for the same course taught at CSULA to college-ready students.

Three improvement practices emerged from the pilot study: (1) implement a strategic student recruitment process that includes alumni involvement and requires student applications, (2) include college math readiness professional development (PD) for high school counselors and

administrators, and (3) add a project component that provides college counseling for students. We also encountered two challenges: (1) few CSULA math professors had the desire and/or capacity to teach at the high schools, and (2) high-performing students wanted to participate in SLAM instead of AP math. The lessons learned from the pilot study were applied in Phase Two.

DE Math Bridge Phase Two: The Math Pipeline Readiness Project (M-PReP) – CSU Expansion and Addition of STEM Pathway (Fall 2016 - Spring 2018).

The initial success of the SLAM Statistics pilot led to the development of a STEM version. The expansion of the project tackled two major issues: (1) readiness for college Calculus, and (2) students' development of a college transition and completion plan. In 2016, College Bridge developed the new Math Pipeline Readiness Project (M-PReP).

M-PReP consisted of three components: (1) deliver PD to align math curriculum and assessments in grades 9-11, demonstrated by increased EAP math readiness rates, (2) provide a Pre-Calculus dual-enrollment course following the model for SLAM Statistics, and (3) prepare students with a coherent strategy to transition into, and through, college. M-PReP added high school counselors to the project to develop, implement, and evaluate a College Transition Bridge (CT Bridge) curriculum for students. The goal for Pre-Calculus was an 80% pass rate.

CSU, Dominguez Hills (CSUDH) and CSULA shared their service area with all Statistics courses run through CSULA and Pre-Calculus courses through CSUDH. Beginning in Fall 2017, all M-PReP schools offered students both options: Pre-Calculus for STEM-bound and Statistics for non-STEM. Funding for this phase came from the MSDF ([redacted]), the CSU Foundation ([redacted]), CSUDH & CSULA ([redacted]), and K-12 districts ([redacted]).

During this phase, 73% (N = 573) of students passed DE Math Bridge Statistics and 86% (N = 128) passed DE Math Bridge Pre-Calculus. Additionally, students at M-PReP schools demonstrated positive trends in EAP outcomes, with 11th grade students in the dual-enrollment

Pre-Calculus course outperforming their counterparts. After controlling for prior levels, there was a statistically significant difference in performance levels between the DE Math Bridge Pre-Calculus and the traditional and honors Pre-Calculus groups (F=4.08, p=.045).

While DE Math Bridge continued to show promise for closing achievement and attainment gaps for low-income, minority students, scaling the project in the CSU faced mounting challenges. The original challenge of limited capacity of CSU math faculty was paired with a new challenge with qualified high school teachers teaching college classes: the teachers were not CSU employees, thus running afoul of collective bargaining agreements. Running the project as a pilot through the Colleges of Extended Education provided temporary shelter, but a solution was needed for scale. Fortunately, by 2018, two key pieces of state legislation were enacted that allowed implementation of the model in the CCC's: AB288 allowed CCCs to claim state apportionment for dual enrollment for underprepared students, and AB705 removed the math placement barrier for access to transfer-level classes. For the next phase, we looked to the CCC's to reach a larger population of students and alleviate the systemic barriers in the CSU.

DE Math Bridge Phase Three: The Math Pipeline Readiness Project (M-PReP) – Community College Expansion to Rural California (Fall 2018 - Spring 2021).

While the first four years of the dual enrollment programs served underprepared CSU-bound students in urban Los Angeles, the next phase of the project expanded to the rural communities of California's Central Valley in partnership with CCCs. This opened the DE Math Bridge intervention to 91% of the student population at the partner high schools.

Students in the Central Valley lag far behind in academic performance compared to the rest of the state. Close to 60% of Valley students from 2nd through 11th grade do not meet the state's expected proficiency levels in math and reading. Additionally, pupils in the Valley are not adequately prepared for college, with only 26% completing the required academic coursework

for eligibility to be admitted to the state's public universities. As a result, most students who decide to pursue a bachelor's degree in the Valley must first begin at the CCCs.

This phase ran two parallel DE Math Bridge programs: (1) the CSU-based STEM and non-STEM pathways in urban regions of Southern California and (2) the CCC-based STEM and non-STEM pathways in the rural Central Valley. All versions of DE Math Bridge included CT Bridge to prepare students to successfully transition to their anticipated college of attendance. This phase also tested variations of DE Math Bridge: (1) a traditional college-level math course taught over one semester, (2) two stretch models with just-in-time intervention, and (3) a pre-requisite model with semester one Pre-Statistics followed by a transfer-level Statistics course in semester two. The different models permitted multiple access points for students that aligned to the three GPA ranges used for math course placement as per AB705 (CCC, 2018). Students in the top tier qualified for placement into the traditional college course. The stretch models accommodated students in the second GPA tier and offered just-in-time support. The pre-requisite model was open to students in the third tier. Funding came from the MSDF ([redacted]), the K-12 Districts ([redacted]), the CSUs ([redacted]), and the CCCs ([redacted]).

In 2018, three new CCCs and three new high schools joined M-PReP. The CCC partnerships yielded the greatest successes with pass rates of at least 91% in all DE Math Bridge courses. One great success was the partnership between Dinuba High School and Reedley College. Over 33% of Dinuba's 451 seniors earned college math credit in high school in the 2020-21 school year. The school completely transformed its math program where all students were provided a pathway to college readiness. Within three years, participation in DE Math Bridge more than quadrupled previous participation in AP math.

While the CCC partnerships provided great promise for expansion and scale of DE Bridge, we experienced challenges administering the CT Bridge Program. Many counselors had neither the knowledge nor the capacity to provide college counseling for students. College Bridge staff repeatedly provided CT Bridge services directly to students with assistance from the DE Math Bridge teachers instead of high school counselors delivering these services.

In the next phase of the program, we are requesting EIR funding to extend our prior promising efforts to (1) solidify a CCC model of DE Math Bridge for scale, and (2) develop, implement, and evaluate an asynchronous CT Bridge model facilitated by DE Bridge teachers.

Information dissemination

College Bridge will partner with the Central Valley Higher Education Consortium (CV-HEC) to implement a multi-tiered information dissemination strategy focused on the Central Valley region, state, and nation. Two annual convenings will take place each year. The first is for partners to convene to share their experiences, outcomes, challenges, and best practices. A student panel will present to allow partners to learn from the student experience, thus capturing student data from individuals who are impacted directly by the program. The purpose of the convening is to inform an annual project improvement cycle. At the second annual convening, DE Bridge partners and students will present their projects and experiences to all 30 higher education partners in the Central Valley and their K-12 counterparts. The purpose is to foster the scale of DE Bridge throughout the region. This event will also include CV-HEC partners from the Dana Center, CSU Fresno, and EdTrust West, all of whom are involved in aligned math projects. In addition, we will present our findings at the National Alliance of Concurrent Enrollment Partnerships Conferences. Additionally, College Bridge and CV-HEC program staff will write articles that will be posted on our websites and disseminated by our partner

organizations at state and national levels. We will share findings through our social media networks and thousands of e-newsletter recipients.

B. Project Design

Rationale and conceptual framework

The rationale for the proposed DE Math Bridge project, as detailed in the preceding section, draws on [redacted] original review of intersegmental interventions, nine years of College Bridge exploratory practice/research projects, and a growing body of literature on the positive impacts of dual enrollment as a strategy to close equity and achievement gaps (Berger et al. 2014; [redacted]; What Works Clearinghouse, 2017; [redacted]).

The DE Bridge project builds upon two theoretical frameworks: Academic Disjuncture Theory and College Readiness Indicator Systems (CRIS). Academic Disjuncture Theory postulates that the overarching barrier to college access and success is "the deeply embedded chasm that separates K–12 from postsecondary education in the United States" (Cevallos et al., 2016). The research suggests that a seamless K-16 educational pipeline is key to unfettered progress for students between educational segments. The disjunctures are most pronounced in the areas of curricula, assessments, financial processes, data systems, and accountability (Brown & Niemi, 2007; Domina & Ruzek, 2012; Kurlaender, Jackson, & Howell, 2012). The DE Math Bridge Project fuses K-12 and higher education together by bridging curriculum, assessments, financial systems, human resources, and student data.

The College Readiness Indicator Systems (CRIS) are valid, reliable, and actionable indicators of three dimensions of college readiness: academic preparedness, academic tenacity, and college knowledge (Borsato, Nagaoka, & Foley, 2013). Academic preparedness includes content knowledge and skills as well as cognitive strategies instrumental to succeed in college

courses. Academic tenacity encompasses the underlying beliefs, attitudes, and values that drive student achievement coupled with behaviors of active participation and perseverance. College knowledge embodies information, skills, and behaviors that foster college access and success.

Target population

The project will serve low-income, Black, or Hispanic high school students, populations both underrepresented and underachieving in college-level math classes, as well as students in rural high schools that lack access to rigorous math courses. The proposed project will include six California Community College (CCC) partners located in California's rural Central Valley and 21 high schools in those CCC's service areas. Thirteen of the high schools are designated rural by locale code and the remaining eight each serve at least 80% low-income and 84% minority students. Since the project aims to reach students who are underprepared for college and may not see themselves as college-bound, a key activity of the project is a strategic Student Recruitment Process (see Appendix J-1). After Year One, project alumni play a key role in student recruitment by presenting at the Student Information Session and Student/Parent Orientation. The project will positively impact approximately 4,000 high school students.

Intervention strategy – DE Math Bridge + and DE Math Bridge Models

The proposed DE Math Bridge project will include four models: two stretch models (*Stats+* and *BSTEM+*) with built-in intervention, and two traditional models (*Stats* and B*STEM*) without intervention. Students have access to a college-level math class and an opportunity to earn transferrable college-math credit in all models. The rationale for offering both intervention and traditional models is two-fold. First, our past research found limited access to rigorous math courses for both underprepared and high-performing students; therefore, this strategy addresses *Competitive Preference Priority 1 - Promoting Equity in Student Access to Educational*

Resources and Opportunities. Second, the impacts of school closures due to the COVID-19 pandemic are unknown. This research, specifically the deep analysis of student assessment outcomes resulting from the Team Grading (see following section) will allow math faculty from the high schools and colleges to determine what, if any, content interventions are needed and apply this knowledge beyond the project. This strategy addresses *Competitive Preference Priority 2 - Addressing the Impact of COVID-19 on Students, Educators, and Faculty.*

Accessibility into the stretch/intervention or traditional model is based on the students' GPA according to the CCC system's placement recommendations set forth in AB705 (see Appendix J-2), with *Stats* $\geq$ 3.0 > *Stats+* and *BSTEM* $\geq$ 3.4 > *BSTEM+*. The number of additional intervention units will vary based on the number of units of the college class and whether the stretch model is over one semester or a school year. The tiered program rollout is presented in *Table 3* below.

Table 3. Three-Year Program Rollout

Project Year	**Year 1 (23-24)**	**Year 2 (24-25)**		**Year 3 (25-26)**			
Program	*Stats +*	*Stats +*	*BSTEM +*	*Stats +*	*BSTEM +*	*Stats*	*BSTEM*
# Students	494	712	595	712	471	454	444

All versions will include the CT Bridge curriculum (Appendix J-3). The project will develop a new version of CT Bridge that is asynchronous, hosted on the Canvas online platform. The CT Bridge will be facilitated by the DE Bridge teachers, thus addressing the limited capacity of school counselors and building capacity within the school to provide college counseling support. DE Bridge teachers will be trained each summer during the Course Planning PD.

Instructor Collaboration and Continuous Improvement Cycle

While the DE Math Bridge program provides students access to college-level math courses, the instructor collaboration and continuous improvement model focuses on student

success outcomes. Each DE Math Bridge model will be taught and assessed by a local team consisting of college and high school math instructors. Partners may employ a co-teaching model with the college instructor leading the college content and the high school teaching leading intervention content. If the high school teacher has the qualifications to be hired by the college, the partners may elect that the high school teacher teaches both college and intervention content.

Regardless of teaching assignment, a college math instructor will participate in course planning, common assessments, and team grading. Teams consist of a college instructor paired with all DE Bridge high school instructors in the college's service area. Each DE Bridge Model has its own team, but instructors may participate in multiple teams. Each team will be led through professional development designed to build relationships and use a Team Grading model for continuous improvement (Cevallos, et al., 2021). Team Grading will provide both quantitative and qualitative data for student, class, and course-level analysis, intervention needs, and revisions. The PD activities are presented in *Table 4* below.

Table 4. PD Cycle for DE Math Bridge Instructional Teams

When	Activity	Outputs
Summer	Team Course Planning	Course Scope and Sequence, PD Calendar, Syllabus, and Collaboration Plan.
Summer	Common Assessments I (development by college instructors)	Common Assessments, Rubric for Team Grading.
August/December	Common Assessments II (review with DE Team)	Assessment Plan and Timeline.
2-3 per Semester	Team Grading	Quantitative and qualitative data to inform intervention content and course revisions.

The college-based site teams will join their regional teams annually to share their findings for an additional layer of data to inform annual course revisions.

Goals, objectives, and outcomes

The goals of DE Math Bridge are: (1) develop and maintain strategic high school/college partnerships to address educational inequities and foster college success, (2) provide an

intersegmental Professional Development program to foster continuous improvement, (3) utilize dual enrollment as a strategy to close equity and achievement gaps, (4) develop a sustainability plan, and (5) scale DE Math Bridge. See *Table 5* for objectives and activities related to the goals.

Table 5: Goals, Objectives/Outcomes, and Activities

Goal 1: Develop and maintain strategic high school/college partnerships.		
Objectives and outcomes	**Metric/Measures**	**Activity (see full table below)**
1.1 Partner with 6 Colleges and 21 High Schools.	# of MOUs	• Regional Launch Convening
1.2 Maintain robust Communities of Practice between partners with data sharing for continuous improvement.	# of sessions, # of attendees, Improvement plans	• Annual Partnership Convening • High School DE Team Meetings
Goal 2: Implement intersegmental Professional Development program to foster continuous improvement.		
2.1 Develop and facilitate a PD program for intersegmental DE Math Bridge teams.	# of attendees and # of sessions	• Instructor PD: Course Planning • Instructor PD: Team Grading • Annual Partnership Convening
2.2 Implement Continuous Improvement PD model for DE Math Instructors	DE subgroup pass rates; course redesigns	• Instructor PD: Course Planning • Instructor PD: Team Grading
Goal 3: Utilize dual enrollment as a strategy to close equity and achievement gaps.		
3.1 Increase participation in college-level math courses for underprepared, underrepresented high school students.	DE Bridge attendance data, # of courses offered annually	• High School DE Team Meetings • Student Recruitment Process • Annual Partnership Convening
3.2 Maintain achievement rates that are similar across minority subgroups.	DE pass rates by subgroup; survey data	• Instructor PD: Team Grading
3.3 Provide at least two access points that provide new opportunities to access college-level math courses.	College readiness metric; HS math sequence	• High School DE Team Meetings • Annual Partnership Convening
3.4 At least 70% of DE Math Bridge students earn a C or higher in the course.	DE pass rates; Continuous Improvement data	• Implement DE Bridge Courses • Instructor PD: Team Grading
3.5 At least 90% of DE Math Bridge students will complete CT Bridge curriculum.	CT Bridge Completion	• CT Bridge Course Development • Instructor PD: Course Planning • Implement CT Bridge Program
Goal 4: Develop a sustainability plan.		
4.1 Develop plans for the continuation of DE Bridge.	# of MOUs and/or CCAP Agreements	• Annual Partnership Convening • Annual CV Regional Convening
4.2 Develop an implementation framework for new partners.	Implementation Handbook	• Annual Partnership Convening • Annual CV Regional Convening
Goal 5: Scale DE Math Bridge.		
5.1 Disseminate information for regional scale throughout the Central Valley.	Database of potential partners	• Annual Partnership Convening • Annual CV Regional Convening

Activities

The activities presented in *Table 6* below illustrate an 18-month cycle of Program Implementation. The cycle will repeat three times for DE Math Bridge implementation in the

2023-24, 2024-25, and 2025-26 school years. Please note that Evaluation Activities are detailed in the Evaluation section and not included below.

Table 6. Implementation Activities & Management Plan

When	What (Activity/Milestone)	Who (Facilitator)	Who (Participant)	Why (Outputs)
Pre-Award Activity	Select Partner Colleges	CV-HEC, CB	CCCs	• Letter of Support from Colleges • List of Potential Math Instructors
Jan 2023	Regional Launch Convening	CV-HEC, CB	CCCs, HSs	• Executed MOUs • Site-Based Goal Setting • Math Course Selection • Instructor Assignments
Jan 2023	High School DE Team Meetings	CB, CCC (optional)	HS Math Dept, Counselors, & Admins	• Student Recruitment Strategy • Math Program Revision (Courses) • Activities Calendar • Annual Improvement Plan
Jan – Jun 2023	CT Bridge Course Development	CB	Students	• CT Bridge Asynchronous Online Course and Implementation Guide
Feb – May 2023	Student Recruitment and Selection	CB, HSs, Rand	Students	• Assignment of Intervention and Control Groups
May – Aug 2023	Student/ Parent Orientation	CB, DE Coord, HS Counselor	Students, Parents	• Registration Paperwork
Aug 2023 and/or Jan 2024	Student Enrollment	CCC DE Coord, HS Counselor	Students	• Course Rosters • Student College ID Numbers
Jun – Aug 2023	Instructor PD: Course Planning	CB	DE Instructors	• Course Docs and Materials • PD Calendar • CT Bridge Implementation Plan
Aug 23 – May 24	Implement DE Bridge Courses	DE Instructors	Students	• Pass Rates for College Math Courses
Aug 23 – May 24	Implement CT Bridge Program	CB, DE Instructors	Students	• Completed College Transition Plans
Aug 23 – Jun 24	Instructor PD: Team Grading	CB	DE Instructors	• Test Grades & Final Course Grades • Data for Continuous Improvement
Summer 2024	Annual DE Bridge Partnership Convening	CV-HEC, CB	All Partners	• Present Site Partnership Reports • Site Improvement Plans
Summer 2024	Annual CV Regional Convening	CV-HEC, CB	Non-Project CCCs and HSs in the CV.	• Dissemination of Project Findings for Scale

C. Management Plan

Project timeline and milestones

The timeline, milestones, and identification of responsible party are incorporated into *Table 6* (above) to illustrate the alignment of the management plan to project activities and outputs; *Table 7* details the roles and responsibilities of the partner organizations.

Roles and responsibilities

Table 7: Roles and Responsibilities

Partner Type	Responsibilities
Central Valley Higher Ed Consortium (CV-HEC) https://cvhec.org/about-cvhec/	• Provide technical support/advisement on CCC agreements. • Coordinate and co-facilitate Regional Launch Convening, Annual DE Bridge Partnership Convening, and Annual CV Regional Convening. • Develop and implement plan for regional project information dissemination and scale throughout the Central Valley.
College Bridge (CB)	• Project Lead: planning, coordinating, and facilitating all project activities. • Provide technical support to all partners in developing agreements, goal setting, intersegmental alignment, instructor assignments, course selection, professional development, student recruitment, and continuous improvement. • Collaborate with Rand on Evaluation Activities, provide data from PD and CB-led project activities, and assist with data collection from partners.
Community College Partners (CCCs)	• Manage student enrollment (role of DE Coordinator). • Create Site DE Team to participate in all Convenings. • Assign Math Instructor(s) to participate all DE Team activities, Instructor PD activities, and to co-teach as needed. • Data sharing with Rand Corp (Evaluation Team).
High School Partners (HSs)	• Assign a designated counselor to facilitate student recruitment and college enrollment activities. • Create Site DE Team to participate in HS DE Team Meetings and all Convenings. • Assign Math Instructors to participate in all DE Team activities, Instructor PD activities, and to teach the DE Bridge Courses. • Data sharing with Rand Corp (Evaluation Team).
Rand Corporation	• Serve as External Evaluation Team (please see Project Evaluation section). • All data collection, analyses, and reporting.

Key project personnel

Table 8 lists key project personnel who will lead the activities noted in *Table 6*. College Bridge key personnel will ensure the completion of activities facilitated by CCC or HS personnel.

Table 8. Key Project Personnel

Name & Major Responsibility	Org	Title	Relevant Training and Experience
[redacted] Project Lead, responsible for all project activities except Rand Evaluation	College Bridge	Founder & CEO	28 years of K-16 math experience; 12 years as PI on math dual enrollment research/practice projects. Expertise: K-16 math alignment; Dual enrollment; Intersegmental partnerships; College Readiness; Professional development; Public education systems.
[redacted] CT Bridge, Student Recruitment	College Bridge	COO	25 years of experience in college counseling; 4 years as PI for CT Bridge. Expertise: College counseling; College access and success; CA's K-12 and Higher Ed systems; Professional development; Student services.
[redacted] Instructor PD	College Bridge	CAO	8 years of experience in curriculum design and teaching. Expertise: Universal Design for Learning; Assessment; Professional development; Blended/Online learning.
[redacted] High School Agreements	College Bridge	K-12 Specialist	11 years leading CA's statewide implementation and monitoring of high school college preparation and readiness programs.
[redacted] CCC Agreements, Convenings, Scale	CV-HEC	Executive Director	36 years of experience in education administration, 15 in K-12 administration and 21 in Higher Ed. Ten years of additional experience leading equity-focused education initiatives in the Central Valley.
[redacted] PI - Evaluation	Rand	Senior Policy Researcher	30 years of research experience; 20 years as PI. Expertise: Dual enrollment, corequisite models, STEM, higher education; Implementation and outcome evaluation; Data collection instrument development; and Project management.
[redacted] Evaluation	Rand	Associate Policy Researcher	Recent Publication Topics: College Readiness, College Counseling, Math, Dual Enrollment, Covid Impacts.

Project costs in relation to project design and management

College Bridge is requesting 69% of funding for DE Math Bridge from the EIR Grant while providing in 26% in matching funds from partner colleges and 5% from CV-HEC (see Appendix H – Match Contributions). The distribution of costs is 65% supporting the dual enrollment programs and continuous improvement model, 14% for external evaluation, 13% for project team meetings and convenings for annual improvement and scale, 8% for administrative support including project management, supplies, and indirect costs.

D. Project Evaluation

Researchers at the RAND Corporation will conduct a rigorous and independent evaluation of the Dual Enrollment Math Bridge (DE Math Bridge) program which will 1) provide feedback to guide program development, 2) assess the fidelity of program implementation, and 3) measure the impact of the program on student achievement and educational attainment. *Table 9* lists the key research questions. The implementation study will examine facilitators of and barriers to high-fidelity implementation and provide continuous feedback to improve program development and implementation fidelity. The impact study will involve a randomized control trial (RCT) designed to meet WWC Evidence Standards without reservations and use valid and reliable outcome measures. In addition, RAND will study variation in program effects across student and school characteristics, and implementation procedures. The evaluation will provide College Bridge timely feedback to support continuous improvement and inform replication efforts.

Table 9. Research Questions

Implementation
1. To what degree is the program implemented with fidelity to the design?
2. What contextual factors enable or constrain implementation of key program dimensions?
Impact Analyses
3. What is the impact of the program on students' high school achievement, including numeracy and problem solving, confidence and attitude towards math, STEM course-taking, high school graduation, and intent to major in STEM fields?
4. What is the impact of the program on postsecondary outcomes, including college enrollment, STEM major, pass rates in college-level math/statistics, and persistence in college?
Covariates and Mediators
5. Does the impact of the program on high school and postsecondary outcomes differ between students of different racial/ethnic and socioeconomic backgrounds?
6. How do contextual factors and fidelity of implementation contribute to the observed effects on student high school and post-secondary outcomes?

Measuring Fidelity of Implementation

Table 10 outlines proposed fidelity measures for the core components of the intervention, including thresholds to assess fidelity to those components.

Table 10. Key Components of the Program and Fidelity Measures and Thresholds

	Core component	Implementation practices
Infrastructure	Partnerships between high school/ community colleges	Number of agreements: 6-21 MOUs signed and CCAP Agreements established or revised, depending on whether agreements are grouped per college or separate per high school.
Professional Development (PD)	Instructor Training	Number of teachers/faculty in PD: 42-84 high school teachers and 10-21 college faculty Training frequency. Once per semester; 48 hours Training topics: Course Planning, Common Assessment & Rubrics, Team Grading Calibration
Dual Enrollment	Students	Student eligibility: GPA < 3.0 for Stats+ and GPA <3.4 for BSTEM+; 3 and above for Stats and 3.4 and above for BSTEM; Number of students: 1918 Stats+, 1,066 BSTEM+, 454 Stats; 444 BSTEM
	Structure of dual enrollment	Stretched model extends a semester or full high school year (5 or 10 units) Team teaching by college and high school faculty
	Student support structure	Support dosage: students with GPA < 3; 2-7 units Support type: pre-planned introductory and review lessons
	College Transition Bridge (CTB) Curriculum	Curriculum dosage: 10 lessons of asynchronous curriculum Topics covered: College applications, FASFA, college selection, general education college requirements, college logistics, and college support services.
Scaling	Expansion	Expand dual enrollment across the 15 regional colleges.
	Share findings and guidance	Two convenings each year led by the Central Valley Higher Education Consortium (CV-HEC) and College Bridge; disseminate findings annually through at least on of the following: state and national organizations including NACEP, Ed Trust-West, the Dana Center, and the Foundation for California's Community Colleges.
Sustain -ability		Plans in place between high schools and colleges to continue implementing DE after grant ends. Framework for the strategic and sustainable use of dual enrollment for expansion across the 15 regional colleges.

Implementation data to inform replication. To answer **RQ1** and **RQ2**, RAND will rely on a combination of observations of instructor training, document collection related to training and program, interviews with instructors/counselors, high school principals, college leaders, and Canvas LMS student use.

Implementation sample and analysis methods. RAND will observe trainings provided to teachers/faculty starting AY2024 through AY2026. RAND will interview a sample 40[1]

[1] A sample of 40 interviews exceeds the 30 interviews threshold to reach saturation (Bernard et al, 2010)

teachers/instructors/counselors representing the high schools and 30 principals, college leaders, and key College Bridge staff during AY2024 through AY2026 to examine fidelity of implementation as well as barriers and facilitators. Leaders of the other colleges in the region will be interviewed to understand plans for expansion of dual enrollment and how findings from the study influenced their decisions. Interviews will be semi-structured to ensure coverage of relevant measures of fidelity, while allowing for respondents' unsolicited input. Documents and transcripts will be coded using Dedoose software and analyzed using a multi-stage iterative approach (Miles and Huberman, 1994). RAND will also collect student use of CT Bridge curriculum from Canvas LMS system (AY2024 -AY2026). Student usage data will be analyzed to produce descriptive information. Themes will be triangulated across interviews, document review of training and course materials, and Canvas LMS data, to attend to all fidelity measures and thresholds (*see Table 10*). RAND will share results annually with the College Bridge team ahead of a formal meeting, ensuring team members have time to process information and reflect on possible changes for better implementation in the subsequent year. RAND will meet with College Bridge informally on a regular basis to discuss urgent design and implementation issues.

Impact Analysis Designed to Meet WWC Standards with Reservations. The impact evaluation **(RQ3 and RQ4)** will be based on a *randomized control trial (RCT)* where students within participating schools are randomized into treatment and control groups. College Bridge has identified 21 schools to participate. These schools are located in California's Central Valley in a mix of urban, rural and suburban areas, and in 14 of the 21 high schools, more than 70% receive free or reduced-price meals. Within each school, 11th and 12th graders will apply to participate in the DE Math Bridge program. As described earlier in **Intervention Strategy**, the courses to which students can apply depends on their GPA; in the years where multiple DE Math

Bridge courses are offered (e.g., Stats+ and BSTEM+) students will apply to specific courses.[2] Approximately half of each school's applicants, for each course, will be randomized to receive an offer to participate in a DE Math Bridge course (treatment group). The remaining applicants will not be offered a slot to participate and will enroll in the usual high school courses (business-as-usual control group). The treatment and control groups will be specific to each course.

Based on prior iterations of the program and school sizes and achievement levels, we anticipate a sample size of approximately 7,764 students total, with 3,882 control students, and 3,882 treatment group students across the four courses: 1,918 in Stats+ course, 1,066 in BSTEM+, 454 in Stats, and 444 in BSTEM. *Table 11* describes the anticipated sample sizes for each year, course, and group. The evaluation focuses on examining the impacts of Stats+ and BSTEM+ as the program is designed to target lower achieving students. The Stats and BSTEM courses targeting higher achieving students are provided to increase students' access to math content and are not the focus of the program, offered during AY2026 and reach fewer students. The evaluation will conduct exploratory analysis on this higher achieving group.

Table 11. Sample Sizes and Years

	Sample Size								**Academic Years**	**Implement during Study Years**
	Stats +		*BSTEM+*		*Stats*		*BSTEM*		*Graduate High School/ Start College*	
	Treat	Control	Treat	Control	Treat	Control	Treat	Control		
AY2023/24	494	494							2024, 2025	1,2
AY2024/25	712	712	595	595					2025, 2026	2,3
AY2025/26	712	712	471	471	454	454	444	444	2026, 2027	3,4

To maximize statistical power, RAND plans to conduct randomization within schools and separately for applicants to each DE Math course offered (Stats+, BSTEM+, Stats, BSTEM).

[2] GPA requirements: GPA <3.0 for Stats+, GPA<3.4 for BSTEM+, GPA≥ 3.0 for Stats, GPA ≥ 3.4 for BSTEM.

This enables us to explain all between-school outcome variance by design. The contamination risk and joiner bias are expected to be minimal as RAND and College Bridge will work closely with schools on randomization and course enrollment, and RAND will confirm randomization. Based on College Bridge's prior implementation, we expect minimal school-level attrition with levels less than 20% and less than 5 percentage points of differential attrition across treatment and control groups. Our impact analyses will meet WWC standards without reservations for all high school outcomes. Since there may be more missing data for the postsecondary outcomes, at a minimum these analyses will meet WWC standards with reservations.

We separately powered our evaluation for the different courses to independently evaluate the impacts of each model. For the Stats+ and BSTEM+ courses, the expected minimum detectable effects are less than 0.25 standard deviations (SDs) for student achievement, 0.15 SDs for survey items, five percentage points (0.15 SDs) for binary outcome measures available for all students, and 10 percentage points (0.20 SDs) for secondary measures only available for students enrolling in college.[3] These are all equivalent to or below the 0.25 SD standard for substantively important effects (WWC Standards Version 4). For the Stats and BSTEM courses, the MDES for achievement is 0.25 when jointly examining these courses (i.e., the access model for high achievers), or 0.35 when examining them separately. Similarly, these courses are independently powered at 10 percentage points or less for binary outcomes available for all students and 5

[3] Power analyses are based on assumptions of 80% statistical power, 0.05 significance level, 50% of sample randomized to treatment, and blocking on schools explains 25% of school-level variance. For test scores, average block size is 40 students and for other outcomes the average block size is 192 for Stats +, 107 for BSTEM +, 45 for Stats, and 49 for BSTEM. For binary outcomes, the MDES calculation is based on author calculations using aggregate data from California and student-level data from two other states. We assume a control group mean of 0.85 for high school graduation (with a SD of 0.3) and 0.60 for college enrollment with a SD of 0.45. MDES for secondary outcomes among college enrollees are based on 50% of the sample enrolling in college.

percentage points when jointly examined. While the independent impacts of the Stats and BSTEM courses may not be powered to meet WWC standards, these are intended to be exploratory analyses, and the pooled analyses comparing courses with supports to those without support are powered to detect substantively important effects.

Valid and Reliable Measures. *Table 12* lists outcome measures, mediators, and covariates for the impact analyses. Most outcome measures will come from administrative data sources. For high school outcomes, we will obtain data from the state, school districts, or schools themselves, and data sharing will be a condition of participation. Postsecondary outcome measures will be obtained from colleges in California's Central Valley with CV-HEC facilitating the data partnerships. Most students at participating high schools attend colleges in the Central Valley.

A few outcomes will be measured using a survey on college intentions and STEM interest, administered to all treatment and control students during class time to obtain high participation rates. The survey utilizes validated measures from "Algebra I" RAND survey previously implemented and validated in a variety of contexts (Pane et al., 2014), as well as Fennema & Sherman validated scales. Our primary measure of math achievement will come from the numeracy and problem-solving assessment from the Program for the International Assessment of Adult Competencies (PIAAC)[4]. The team will administer the online assessment to a sample of treatment and control students based on the 2017 version of the PIAAC.[5] This assessment has been extensively analyzed and deemed a reliable and valid measure of basic

[4] Program for the International Assessment for Adult Competencies (PIAAC) (ed.gov)

[5] A newer version of the PIAAC will be used, and continued, if available before first administration. The assessment is costly to administer, so we will only administer it to the minimum sample needed for an MDES of 0.25, including 600 treatment students, evenly split across Stats+, BSTEM +, and Stats or BSTEM, and an equivalent number of control students for each group.

numeracy skills for adults ages 16-65 in a variety of settings (Hogan et al, 2014; OECD, 2013c). We will administer the assessment electronically in the last month of the academic year. For additional valid outcome measures we will use administrative data on high school graduation, STEM course-taking in 12th grade, college enrollment, persistence and pass rates. These measures meet WWC design standards (Version 4.1).

Table 12. Outcome Measures and Data Sources

Specific Measures	Data Sources	Academic Years of Data
Outcome Measures		
High School Outcomes		
Numeracy and problem-solving	PIAAC assessment	AY2024-AY2026
High school graduation	Administrative data (from school, district, state)	AY2024-AY2027
12th grade STEM course enrollment	Administrative data (from school, district, state)	AY2025-AY2027
Math confidence, STEM interest, STEM major intent, College intent	Validated RAND Algebra I Student survey Adapted from Fennema & Sherman (1976)	AY2024-AY2026
Postsecondary Outcomes		
College enrollment (two- or four-year)	Colleges in the CV-HEC	AY2025-AY2027
Pass college-level math	Colleges in the CV-HEC	AY2025-AY2027
Persistence in first semester (and, where possible, year) of college	Colleges in the CV-HEC	AY2025-AY2027
Mediators		
Course characteristics (including supports and length)	Original data collected by College Bridge and RAND Student surveys, RAND interviews	AY2024-AY2026
Student engagement with the College Transition Bridge Curriculum	Data from high school Canvas LMS	AY2024-AY2026
Teacher/Faculty PD	Original data collected by RAND	AY2024-AY2026
	Covariates and Descriptive Information	
Student Demographics	Administrative data (from school, district, state)	AY2024-AY2026

Analytic Approach for the Impact Study (RQ3 and RQ4). Primary (confirmatory) analyses will examine student outcomes at the end of their first year of participation (end of 11th or 12th grade), at the end of high school, and in the first year after high school to capture college outcomes.[6] Impacts will be estimated using the two-level hierarchical linear model below:

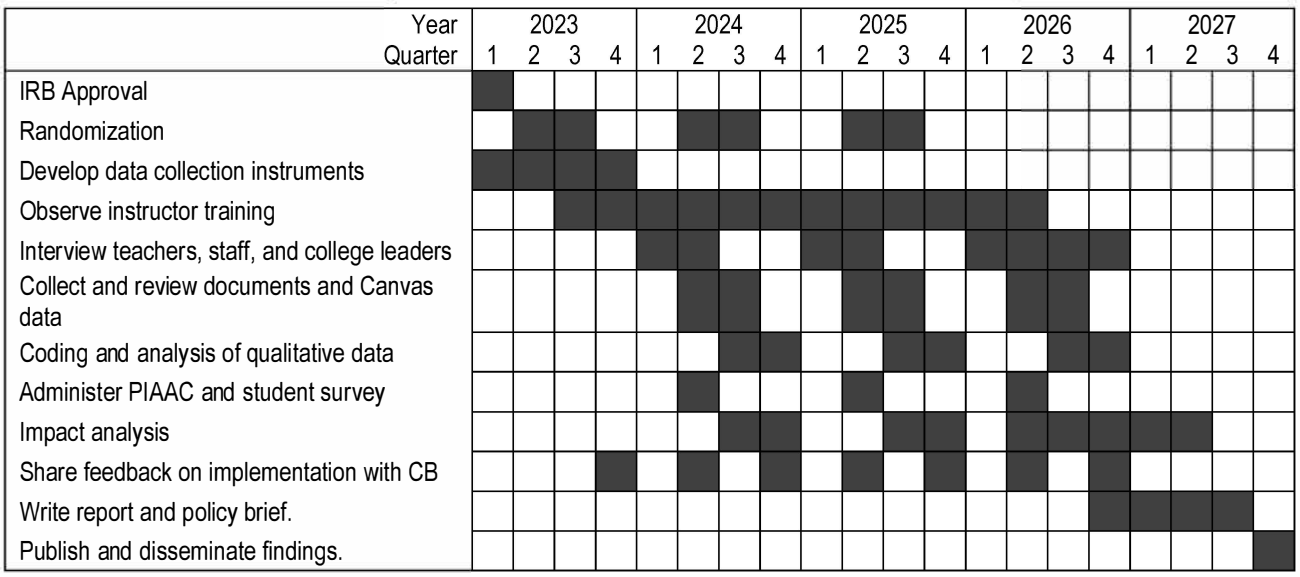
[6] We will look at 12th grade course-enrollment for the set of students who enroll as 11th graders. These analyses are exploratory and may not be fully powered since less than half the sample is likely to enroll in 11th grade.

$$Y_{ij} = \beta_0 + \beta_1 Trt_i + \boldsymbol{X_{ij}'\beta_2} + \boldsymbol{Z_j'\beta_2} + \varepsilon_{ij}$$

where *i* denotes students; *j* denotes the high school; Y_{ij} is the outcome; Trt_i is the original random assignment status of the student *i*; $\boldsymbol{X_{ij}}$ is a vector of student baseline covariates; $\boldsymbol{Z_j}$ is a vector of covariates including indicators for schools (to account for random assignment within schools); and ε_{ij} is the student-level residual. For binary outcomes, we will fit a logistic model. For **RQ5** and **RQ6**, we will examine differences by student characteristics and moderators (including contextual factors and implementation fidelity) using modified impact models which interact Trt_i with the moderators or measures of student characteristics (e.g., low-income).

Evaluation Timeline. RAND will meet monthly with College Bridge to provide informal progress reports. RAND will also formally brief College Bridge annually to provide formative feedback on implementation that can guide continuous improvement, scaling and replication. In 2027, RAND will publish a final peer-reviewed report and recommendations on improvement and will develop a framework with College Board to guide implementation based on results. Please see Evaluation Timeline below.

Evaluation Timeline: January 1, 2023 to December 31, 2027



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