Tennessee SySTEM for College and Career Readiness Project

Table of Contents

INTRODUCTION

The Tennessee SySTEM for College and Career Readiness Project ("the Project"), led by Jobs for the Future (JFF) with the Tennessee Department of Education (TDOE), will develop, implement, and test the feasibility of an innovative approach to STEM and computer science (STEM/CS) education for 11th and 12th graders. ***The Project will implement work-based courses (WBC) in high schools across Tennessee (TN).*** WBC are defined as STEM/CS-focused courses that integrate classroom and work-based learning (WBL) in courses that are co-taught by academic faculty and employer instructors, creating a model that embeds WBL in the curriculum in a powerful way. WBC will be structured as early postsecondary opportunities (EPSOs), such as dual enrollment (DE), dual credit (DC), and Advanced Placement (AP) courses. Course content will be taught both in classroom settings (remote and in-person) and through applied learning that uses the workplace as a laboratory, enabling students to simultaneously earn early postsecondary credit and gain workplace skills that prepare them to enter and succeed in STEM/CS careers. This integration of EPSOs and WBL improves student outcomes because the classroom and applied components of the design reinforce one another. By leveraging employer instructors, WBC will also address the existing shortage of STEM/CS teachers in TN.

The Project will support 20 high schools across TN to establish new STEM/CS WBC in partnership with regional postsecondary institutions and employers. The Project will serve high-need students, defined as those who are Black, Hispanic, female, and/or economically disadvantaged, in the 11th and 12th grades. To ensure improved student outcomes, strong academic supports and career advising will be embedded as core components of the Project.

JFF's proposed EIR grant ***addresses Absolute Priority 1–Demonstrates a Rationale***. Extensive research demonstrates the effectiveness of EPSOs in improving student outcomes, and the Project will prioritize DE as a particularly effective EPSO model. A February 2017 What

Works Clearinghouse (WWC) intervention report found that DE has positive effects on students' degree attainment (college), college access and enrollment, credit accumulation, completing high school (HS), and general academic achievement in HS, with a medium to large extent of evidence.[1] Research shows a correlation between student participation in EPSOs and higher outcomes on college and career readiness assessments, such as the ACT[2], and higher graduation rates.[3] The evidence base for WBL at the HS level demonstrates that it improves academic outcomes at the secondary and postsecondary levels,[4] supports positive youth development and fosters employability skills,[5] and leads to improved job quality later in life.[6] An evaluation of a WBC pilot led by JFF found that WBC improved academic and career outcomes.[7] The project also ***addresses Absolute Priority 2–Field-Initiated Innovations–STEM*** and ***Competitive Preference Priority 1–Computer Science***. Through the implementation of WBC in high schools across TN, the Project will develop, implement, and replicate an entrepreneurial, evidence-based, and field-initiated innovation that improves high-need students' achievement and attainment in STEM/CS education. By improving college and career outcomes for high-need students, the Project will create a skilled STEM/CS workforce prepared to enter and succeed in in-demand career fields in TN. Led by the American Institutes for Research (AIR), ***the evaluation will test the feasibility of WBC as a strategy to improve students' college and career readiness and STEM/CS skill attainment***. The Project will further ***generate a robust suite of public goods*** (e.g., tools, resources, publications) to support WBC replication.

A. QUALITY OF PROJECT DESIGN

A1. Goals, Objectives, and Outcomes. The Project, as shown in the logic model in Figure 1, will ***measurably improve the educational and career outcomes of high-need students***, including HS outcomes, postsecondary enrollment and attainment, and career readiness. In Year 1, the

Figure 1. Project Logic Model

Inputs	Activities	Outputs	Outcomes
Financial Resources • Implementation grants for 20 schools • High-quality technical assistance • TN DE and pathways grants, TN Promise, and Future Workforce Initiative **Implementation Resources** • TN Pathways Designation • TN Computer Science State Education Plan • TN STEM School Designation **Institutional Capital** • TDOE high schools • Access to JFF and its Pathways to Prosperity Network	**Creation of WBC Blueprint** • EPSOs aligned to educational and industry standards • WBL supports technical and employability skill development • Focused academic supports and career advising **Implementation** • Competitive grants • Blueprint guidance and technical assistance, including site visits and tools • Community of practice • Training for employer supervisors and mentors **Tool Development** • STEM/CS competency maps • Implementation and sustainability guidance • Academic support, career advising, and communications toolkits **Continuous Improvement** • Student surveys and focus groups • Technical assistance	**Schools** • WBC bring together STEM/CS EPSOs and WBL • Increased STEM/CS-focused academic supports and career advising for high-need students • Increased availability of STEM/CS teachers **TDOE** • Expanded set of tools and resources to increase access to EPSOs and WBL through WBC • New curricular and student support resources to support implementation of TN Pathways, TN COIN, and CS State Education plan	**High-Need Students** • Improved achievement on performance tests • Increased attainment of postsecondary credit • Increased college enrollment and industry credential attainment • Increased representation in STEM/CS fields **Schools** • Increased capacity to help students become college and career ready in STEM/CS fields **Nationally** • Expansion of knowledge and resources to replicate WBC

the Project will establish a baseline for performance to measure overall progress over the five-year grant period, as reflected in the goals, objectives, and outcomes in Table 1 below.

Table 1. Measurable Goals, Objectives, Performance Measures, and Outcomes

Objectives	Performance Measures	Outcomes
Goal 1. Design, implement, and expand WBC in order to *increase high-need students' access to, participation in, and completion of STEM/CS EPSOs and WBL*		
O1.1: Design and implement WBC that embed STEM/CS EPSOs and WBL **O1.2:** Increase the number of high-need students who enroll in and successfully complete STEM/CS EPSOs **O1.3:** Increase the number of high-need students who participate in and successfully complete STEM/CS WBL **O1.4:** Increase students' and families' understanding of the value of STEM/CS	**PM1.1:** At least 20 new schools creating and offering WBC, disaggregated by rural, urban, and suburban **PM1.2:** At least 40 new WBC created over the grant period **PM1.3:** 10% annual increase over baseline in the proportionate representation of high-need students enrolled in STEM/CS EPSOs, disaggregated by subgroup **PM1.4:** 10% annual increase over baseline in the proportionate representation of high-need students completing STEM/CS EPSOs, disaggregated by subgroup **PM1.5:** 10% annual increase over baseline in the proportionate representation of high-need students participating in STEM/CS WBL, disaggregated by subgroup	• All participating schools are offering high-quality, innovative WBC • Through WBC, high-need students are enrolling in STEM/CS EPSOs at rates proportionate to their overall enrollment • Through WBC, high-need students are participating in STEM/CS WBL at rates proportionate to their overall enrollment • High-need students and their families have greater awareness of STEM/CS opportunities

Goal 2. Increase students' *academic achievement and college and career readiness and outcomes*		
O2.1: Increase STEM/CS academic achievement for high-need students **O2.2:** Increase college and career readiness of high-need students **O2.3:** Increase high-need students' HS graduation rates **O2.4:** Increase high-need students' college-going rates **O2.5:** Improve high-need students' career outcomes in STEM/CS fields	**PM2.1:** 50% of students who complete WBC will achieve composite ACT scores equal to or greater than the state median **PM2.2:** 50% of students who complete WBC will achieve ACT math and science subscores equal to or greater than the state median **PM2.3:** 10% annual increase over baseline in student engagement as measured by student attendance, disaggregated by subgroup **PM2.4:** 10% annual increase over baseline in the number of HS students who earn STEM/CS postsecondary credit, disaggregated by subgroup **PM2.5:** 5% annual increase in the number of students graduating HS (or on-track to graduation) after four years **PM2.6:** 5% annual increase in number of students enrolling in postsecondary education (including 2- and 4-year degrees) after HS **PM2.7:** 5% annual increase in number of students completing a STEM/CS industry-recognized credential, certificate, or license	• WBC foster college and career readiness and success for high-need students • High-need students enter and succeed in postsecondary programs of study in STEM/CS fields • High-need students pursue and succeed in careers in STEM/CS fields
Goal 3. Build the *capacity of schools* to offer high-quality and innovative WBC		
O3.1: Increase the capacity of schools to build strategic partnerships with postsecondary institutions and employers to design and implement WBC **O3.2:** Increase the number of available STEM/CS teachers through WBC design that engages industry professionals as teachers **O3.3:** Improve academic supports for high-need students in STEM/CS courses **O3.4:** Increase the availability of, and student participation in, STEM/CS-focused academic and career advising **O3.5:** Create sustainable model for WBC implementation **O3.6:** Create opportunities for	**PM3.1:** All Project high schools have strategic partnerships with at least one postsecondary institution and one employer **PM3.2:** All partnering employers have at least one staff member who serves as a WBC teacher **PM3.3:** All WBC teachers attend professional development focused on implementing WBC blueprint **PM3.4:** At least 80% of WBC students receive information and support from teachers or advisors regarding skills to support WBC course **PM3.5:** At least 80% of WBC students participate in at least one 1:1 STEM/CS course advising session each year **PM3.6:** At least 80% of WBC students participate in at least one advising session focused on career options, prerequisites, and work skills **PM3.7:** All schools implementing WBC	• Schools in TN increase their capacity to offer high-quality, innovative WBC • Secondary and postsecondary educators and employers are actively collaborating to support increased access to STEM/CS content and training • High-need students have greater access to STEM/CS academic supports and

Project schools to learn from evidence-based best practices and from one another	develop sustainability plans **PM3.8:** Hold biannual Project community of practice convenings	career advising
Goal 4. *Codify and disseminate best practices* in creating WBC		
O4.1: Document how the Project develops, implements, and tests WBC to improve educational and career outcomes for high-need students **O4.2:** Share Project processes, practices, and findings nationally, with active outreach to education leaders in other states and regions	**PM4.1:** At least four tools designed to assist other states and regions in replicating or adapting Project-related policies and practices **PM4.2:** At least two publications documenting Project successes and challenges (e.g., case studies, policy briefs, online blogs, reports) **PM4.3:** Present on the Project to at least two national conferences with a similar focus (e.g., EPSOs, WBL, college and career pathways)	• The Project inspires and informs the development of scaling strategies for WBC in other states and regions • The Project expands the evidence base about effective practices to improve the educational and career outcomes of high-need students and creates actionable tools and resources for policymakers and practitioners

A2. Target Population. The Project's priority population is 11th and 12th graders, with a focus on those who are ***Black, Hispanic, female, and/or economically disadvantaged***. This focus addresses existing inequities in achievement, attainment, and career outcomes among TN students. The Project will prepare high-need students for in-demand, high-wage jobs in STEM/CS fields. TN will add 29,850 STEM jobs by 2026;[8] STEM/CS jobs are expected to grow almost twice as quickly as all other occupations in the state.[9] Computing occupations are the primary source of new wages in the US, and 67% of all new TN STEM jobs are in computing.[10] The median salary of STEM industry workers in TN is $70,849, which is more than twice the median salary of all employed Tennesseans.[11] Yet there are significant disparities in which workers have access to these promising careers. A 2018 study found that Black and Hispanic workers are underrepresented in the STEM workforce: Black workers make up 11% of the U.S. workforce, but only 9% of STEM workers, while Hispanic workers are 16% of the total workforce, but only 7% of STEM workers.[12] Although women make up about half of U.S. STEM workers, they are concentrated in low-wage clusters, making the gender wage gap in

STEM wider than in non-STEM career paths (a pattern mirrored for Black and Hispanic workers as well).[13]

Although STEM/CS jobs are vital to growing the TN economy, there will be a significant shortage of qualified candidates if educational trends in TN are not reversed soon—and this problem is particularly acute in the case of high-need students. Only 11% of STEM bachelor's degrees in TN are in Computer Science.[14] The Tennessee Board of Regents (TBR) reported that only 2,381 students (3.5% of the student population) were enrolled in Computer & Information Sciences programs in 2019.[15] Student interest is not the reason for this disparity: 46 percent of TN students were interested in STEM in 2017, but only 29% met the ACT STEM benchmark.[16] High-need students, in particular, lack access to the educational supports and opportunities needed to enter and succeed in STEM/CS careers. Only 83.7% of Black students and 84.1% of Hispanic students in TN graduate from HS on time, compared with 92.7% of white students.[17] In 2019, only 82.9% of economically disadvantaged students graduated, compared to 94.3% of non-economically disadvantaged students.[18] In 2016, only 63% of HS graduates enrolled in a postsecondary institution in the summer or fall following their graduation, and the numbers were significantly lower for students who were Black, Hispanic, or economically disadvantaged.[19] Among first-time, full-time students at public two-year colleges in TN, 26.9% of white students complete their programs within three years, while only 10.5% of Black students and 22.4% of Hispanic students do the same.[20] Only 47% of Black students persist in a TBR college after their first year, as compared to 60% of white students.[21]

The participation of high-need students in TN in core components of the Project's WBC model—EPSOs and WBL—is disproportionately low. In 2019, only 30% of all AP Computer Science exams taken in TN were taken by female students, 13% were taken by Black students, and 8% were taken by Hispanic students.[22] Data from 2020 shows that more than 70% of students of color and economically disadvantaged students do not participate in any EPSOs during high school.[23] Nearly 8% of high schools in TN do not offer a single EPSO, meaning that nearly 1,200 HS students have no access to EPSOs of any kind.[24] Economically disadvantaged students are twice as likely as their peers to lack access to EPSOs.[25] In the third quarter of this year (the most recent data available), less than 23% of TN HS students participating in WBL were Black or Hispanic, and only 19% were economically disadvantaged.[26]

Through creation and implementation of WBC, the Project will improve outcomes for high-need students by addressing disparities in access to EPSOs and WBL. In addition, the Project will support high schools in building and expanding academic supports and career advising for high-need students in order to ensure that they are positioned to succeed in WBC. The design of WBCs will also address transportation barriers that may prevent high-need students from participating in EPSOs and/or WBL. WBC will be designed to be offered through both remote learning and in-person models in which the classroom and hands-on components are co-located in workplaces in order to minimize the need for transportation.

A3. Research and Effective Practice. The Project will implement and scale research-based strategies to design and implement WBC that will measurably improve the educational and career outcomes of high-need students. Research has demonstrated a correlation between enrollment in EPSOs in TN and achievement on college and career readiness assessments such as the ACT.[27] EPSOs are associated with higher graduation rates; the graduation rate in TN schools that do not offer at least one EPSO is under 60%, whereas schools with at least one EPSO graduate students at a rate of 88.5%.[28] TDOE research shows EPSOs to be particularly effective for economically disadvantaged students, as nearly 75% of those who took an EPSO enrolled in a postsecondary institution after graduating HS, which was higher than the 42% rate for economically disadvantaged students who did not take an EPSO, as well as the 66% rate of non-economically disadvantaged students who did not take an EPSO.[29]

DE is an especially effective EPSO model and will be prioritized in WBC design. A February 2017 What Works Clearinghouse intervention report definitively confirms that ***DE has positive effects on academic attainment and achievement at the secondary and postsecondary levels with a medium to large extent of evidence—and that it has no negative effects***.[30] Evidence for DE is strong in multiple outcome domains, including improving college degree attainment, college access and enrollment, credit accumulation, completing HS, and other general HS academic achievement.[31] Another study found that DE's effects were even stronger for low-income students.[32] Students enrolled in DE courses are more likely to graduate with a bachelor's degree in three, four, or five years than those who have not participated in DE.[33] Research has also demonstrated that TN students who took DE courses were more likely to take AP classes later in their HS careers and more likely to attend four-year institutions than their peers.[34] The Project will also seek to improve access to AP courses, including AP Computer Science. Both the College Board and independent researchers have found that student participation in AP classes is associated with higher academic achievement.[35] ***Multiple studies have found that students who pass AP exams in HS do better in college and had higher college graduation rates than those who did not take AP classes.***[36] If students pass the AP exam, they are more likely to graduate with a college degree in three years.[37]

There is a strong evidence base for the effectiveness of WBL in engaging youth and preparing them for college and careers. When students participate in meaningful WBL experiences, they not only have higher rates of HS and college completion, they transition to postsecondary education with a clearer idea of the careers and relevant programs of study they want to pursue.[38] ***WBL positively affects postsecondary enrollment.*** A seven-year study of one California WBL program revealed that students who completed a WBL program entered college at double the rate of non-participating students.[39] WBL opportunities support the development of the employability skills sought by employers while enhancing positive adolescent development by cultivating students' social and communication skills, self-awareness, self-confidence, and positive attitudes about the future.[40] ***Students who participate in WBL in HS develop skills sought by employers, leading to improved job quality (measured by wages, benefits, hours, and job satisfaction) when those students are in their twenties.***[41] Recent graduates with relevant work experience are more likely to be employed full-time, engaged at work, and advanced into skilled occupations than those who only work or attend school.[42] An evaluation of a pilot of WBCs designed for community college students found that incumbent workers enrolled in the courses academically outperformed their peers, with an average GPA of 3.90 (compared to 3.52) and earned an average of 11 academic credits.[43] Two-thirds of WBC students indicated that the courses prepared them for new jobs, and 43% said they facilitated wage increases.[44]

A4. Contribution to Knowledge. The Project will develop, implement, and test the feasibility of WBC in order to contribute to knowledge about effective practices in STEM/CS education that improve college and career outcomes for high-need students while fostering economic competitiveness. The Project will leverage and contribute to knowledge and the development of effective practice for four key related statewide initiatives in TN: **1) TN Pathways**,[45] launched in 2012, is a TDOE and TBR initiative that supports the development and scaling of college and career pathways aligned with regional labor-market demand. EPSOs, WBL, and advising are key components of these pathways, which are certified by TDOE through a designation process, and

TDOE provides competitive grants to support pathways development. For the past eight years, JFF has provided technical assistance to TN Pathways through TDOE's membership in the Pathways to Prosperity (PtoP) Network; **2) Cooperative Innovative High School Programs**, authorized by the TN Code,[46] authorize local education agencies and public postsecondary institutions to create innovative programs, including DE and/or DC, to improve students' college and career outcomes; **3) TN's Computer Science State Education Plan**[47]—through which TDOE that TN students in grades K-12 are prepared for careers now and in the future—includes measures that require all public HS students to take at least one CS class and aims to increase the number of underrepresented students earning CS-based college credit while in HS; and **4) the Future Workforce Initiative**, launched by Governor Bill Lee in 2019, aims to increase STEM training in K-12 schools and put TN in the top 25 states for creating technology jobs by launching new CTE and STEM-focused programs in public schools.[48] The initiative includes a STEM school designation that provides schools with stipends and peer learning opportunities.

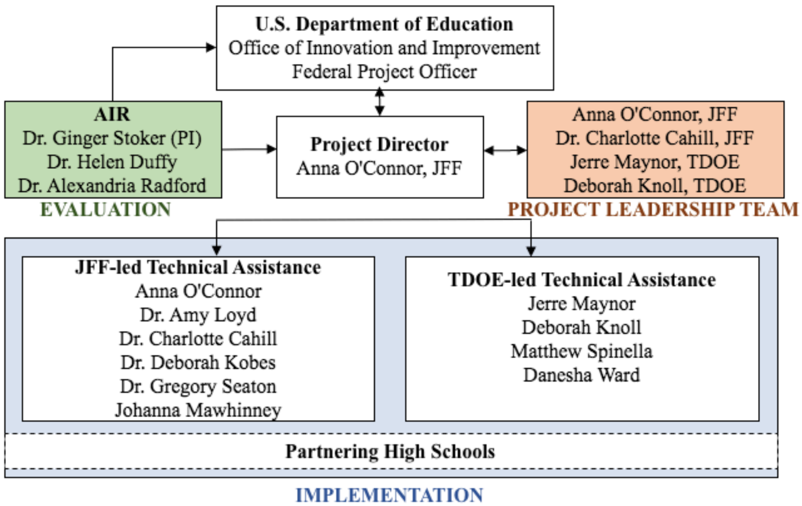
Beyond generating knowledge to accelerate and improve statewide STEM/CS education initiatives, ***the Project will increase knowledge and understanding of strategies that address three urgent issues in education in TN and nationally***: 1) the need to improve student achievement, attainment, and college and career outcomes, particularly for high-need students, though high-quality EPSOs and WBL—and how WBCs can amplify the effects of both interventions; 2) the limited number of teachers qualified to teach STEM/CS; and 3) the lack of career advising and academic supports required to close achievement and attainment gaps and ensure that high-need students participate and progress in STEM/CS fields.

EPSOs, WBL, and WBC: As noted above, research has already demonstrated the positive effects that EPSOs and WBL each have on educational achievement, attainment, and college and career readiness. The Project will make a significant contribution to knowledge in this area by producing research that assesses WBC as a strategy for integrating EPSOs and WBL in order to increase their effectiveness in these domains. Augmenting research on a WBC pilot at the community college level, which demonstrated that WBC have positive effects on academic achievement and career outcomes, the Project will build knowledge of how to implement WBC at the high school level in order to achieve similar outcomes.

STEM/CS Teachers: There are currently not enough teachers—in TN or nationally—qualified to teach STEM/CS, an issue that disproportionately affects high-need students.[49] However, TN districts face a widespread teacher shortage,[50] and districts struggle to hire teachers for HS math and science.[51] The Project will contribute to knowledge of effective strategies to address this problem through developing a model in which industry professionals share teaching responsibilities with classroom teachers. This model will build our understanding of how to address the shortage of qualified teachers while simultaneously bolstering students' career readiness and outcomes though the creation of opportunities to learn from industry professionals.

STEM/CS Career Advising Support: There is an equally concerning gap between the number of students and access to effective career and college advising while in HS. [52] The Project will increase student participation in STEM/CS-focused advising by increasing the number of trained advisors and creating effective and relevant tools and training resources. The Project will contribute to knowledge and understanding of how to build the capacity of advisors and schools to support high-need students in STEM/CS courses and programs of study.

Figure 2: Organizational Chart



B. ADEQUACY OF RESOURCES AND QUALITY OF THE MANAGEMENT PLAN

B1. Management Plan. The Project will be implemented through a partnership between JFF and TDOE to develop and implement STEM/CS WBC that improve outcomes for high-need students. Since 2012, TDOE has been a member of JFF's PtoP Network, a collaboration among JFF and 15 states and 40+ regions across the country that are building and scaling college and career pathways. JFF supported TDOE to develop a statewide certification to expand college and career pathways. JFF is a national leader in the design, implementation, and scale of EPSOs (DE and DC). WBC have been created and piloted by JFF, and JFF's Center for Apprenticeship and WBL provides national leadership and technical assistance on WBL.

The organizational chart establishes the reporting relationships for the partner organizations (see Figure 2). Our plan is more than adequate because each partner organization is highly qualified for a clear and specific role involving execution of the goals and objectives (see Table 1) at for each activity and milestone on the project's 5-year timeline (see Table 2).

Table 2: Activities, Milestones, Timeline (by Year and Quarter), and Responsibilities

Milestones	Date Due	Responsible Parties (Lead in bold)
Goal 1. Design, implement, and expand WBC in order to *increase high-need students' access to, participation in, and completion of STEM/CS EPSOs and WBL*		
Design RFP for two grant cycles	Y1/Q2	**TDOE**, JFF
Create competitive preference for high-need students; computer	Y1/Q2	**TDOE**, JFF

science; TN certified pathways; and structures in place that prepare students early for STEM/CS academics		
Release RFP	Y2-3/Q1	**TDOE**
Review applications	Y2-3/Q2	**TDOE**, JFF
Award grants to partnerships	Y2-3/Q2	**TDOE**
Develop WBC Blueprint	Y1/Q1-2	**JFF,** TDOE
Refine WBC Blueprint	Y5/Q1-2	
Develop a communications toolkit and resources for schools	Y1/Q3	**TDOE**
Convene employers and conduct desk-based research to map STEM/CS competencies	Y2-4/Q2-3	**JFF**
Develop STEM/CS competency maps that identify relevant skills and knowledge for STEM/CS careers	Y2-4/Q2-3	
Work with employers and educators to design WBL component of WBC	Y2-4/Q2-3	
Work with educators to design EPSOs component of WBC	Y2-4/Q2-3	
Facilitate collaboration between employers and faculty to design WBC that connect EPSOs and WBL	Y2-4/Q2-3	
Goal 2. Increase students' *academic achievement and college and career readiness and outcomes*		
Conduct annual individual site visits to Project schools	Y2-4/Q3-4	**TDOE,** JFF
Develop implementation guidance	Y1/Q3-4	**JFF**
Develop WBL assessment tool designed to organize and document learning in both the classroom and the workplace	Y1/Q3-4	
Develop sustainability guidance	Y2/Q1-2	
Goal 3. Build the *capacity of schools* to offer high-quality and innovative WBC		
Design STEM/CS academic support toolkit	Y2/Q1-2	**TDOE**
Design STEM/CS career advising toolkit	Y2/Q1-2	
Train educators and employer supervisors and mentors	Y2-4/Q1-4	**JFF**
Provide school and district leaders with coaching and guidance on the development of partnerships with postsecondary institutions and employers	Y2-3/Q2-3	**JFF**
Goal 4. *Codify and disseminate best practices* in creating WBC		
Hold biannual virtual community of practice convenings	Y2/Q4; Y3-5/Q2&4	**JFF**, TDOE
Document best practices in two publications	Y5/Q1-4	**JFF**, TDOE
Present at two national conferences	Y5/Q1-4	
Highlight the Project and related resources on websites accessed by key national audiences	Y3-5/Q1-4	
Project Management		
Develop detailed project work plan; update annually based on feedback and evaluation	Y1-Y5/Q1	**JFF**
Hold bi-weekly Technical Assistance Team meetings	Y1-5/Q1-4	**JFF**, TDOE
Hold monthly Project Leadership Team/AIR implementation review meetings	Y1-5/Q1-4	**JFF**, TDOE, AIR
Review formative evaluation conducted by AIR and use to improve implementation activities	Y2-5/Q1	**AIR**, JFF, TDOE

Hold annual all-partner summative evaluation meeting	Y2-5/Q1	**AIR**, JFF, TDOE
Send quarterly email to all TNCOIN partnerships providing updates and soliciting feedback	Y1/Q3, Y2-5/Q1-4	**TDOE**, JFF, AIR

JFF will manage and oversee the Project and will leverage its national expertise in WBC, EPSOs, WBL, STEM college and career readiness, and advising to help TDOE design, implement, and refine the systems necessary to design high-quality WBC and implement them with quality, fidelity, and equity. ***TDOE*** will provide support for WBC implementation, administer the Project's competitive grant process, and coordinate relationships with schools and districts and TBR. ***AIR*,** a leading social and behavioral research firm that serves as the evaluator of numerous EIR early- and mid-phase projects, will conduct the independent evaluation.

B2. Reasonableness of Costs. Project costs are reasonable given the depth of direct support and TA provided to educators and schools, the frequency of convening throughout the project to accelerate learning, the development of publicly available tools and resources for replication in the field, and the rigorous evaluation that will test the efficacy of the Project's activities (see Table 2). The Project will support the development of strategies that lead to increased efficiency that builds upon TDOE's current pathways efforts and infrastructure across TN. The Project leverages TDOE's long-standing relationship with JFF's PtpP Network to scale and increase impact at state and national levels. As such, Project costs are an investment in the development of vetted practices, tools, strategies, and resources that will sustain, scale, and replicate the goals of this project beyond the grant period in TN and beyond.

The reasonableness of costs is also reflected in how matching funds from TDOE, which will flow directly to partnering high schools to maximize the number of high-need students served, will be used to support the Project. In addition, WBC will leverage TN's dual enrollment grants, funded by the TN Lottery, to ensure that students and their families are not responsible for tuition costs. Similarly, the Project positions students to take advantage of the Tennessee Promise initiative to receive two years of free tuition at TN's community and technical colleges.

JFF and TDOE will also assist partner schools with sustainability planning to help them maximize available local, state, and federal resources, and apply philanthropic investments in targeted areas of need to continue and expand WBC implementation beyond the project period. In addition, the WBC model will be designed for replication and TDOE will support scaling across TN beyond the project period. Finally, the Project's broad dissemination strategy (see Section B5) will ensure that WBC are replicable nationwide.

B3. Qualifications of Personnel. Each project partner brings a highly qualified team with the expertise that will ensure successful implementation of the Project, as indicated in Table 3.

Table 3. Key Personnel and Qualifications

Key Personnel	Qualifications and Training
Anna O'Connor, JFF, Associate Director	Leads implementation of mid-phase EIR grant with a focus on STEM/CS and cybersecurity pathways in Texas; expertise in EPSOs and WBL; leads JFF engagement with TDOE through the Pathways to Prosperity Network; M.P.P., Brandeis University
Dr. Amy Loyd, JFF, Vice President	Leads JFF program units focused on college and career pathways and WBL; launched Pathways to Prosperity Network; Ed.L.D., Harvard Graduate School of Education
Dr. Charlotte Cahill, JFF, Senior Director	Leads Pathways to Prosperity Network and other initiatives focused on EPSOs and WBL; oversees JFF engagement in two existing EIR awards (early-phase and mid-phase); Ph.D., Northwestern University
Dr. Deborah Kobes, JFF, Senior Director	Created and piloted the WBC concept with funding from the National Science Foundation; Deputy director of Center for Apprenticeship and WBL; Ph.D., Massachusetts Institute of Technology
Dr. Gregory Seaton, JFF, Associate Director	Leads implementation of STEM career exploration curriculum and provides technical assistance on STEM pathways; expertise in advising and positive youth development; Ph.D., University of Pennsylvania
Joanna Mawhinney, JFF, Program Mgr	Expertise in designing supports for high-need students and program and partnership management; B.A., Amherst College
Jerre Mayor, TDOE Senior Director, Career Pathways	Leads TN Pathways, an initiative that incorporates EPSOs, WBL, and advising; Master of Educational Leadership, Broad Center; M.A., Harvard Graduate School of Education
Deborah Knoll, TDOE Director, K12 Programs &	Leads implementation of TN's state framework for computer science education and of STEM education statewide; M.A.T., Bellarmine University

STEM Initiatives	
Matthew Spinella, TDOE Director, WBL & Industry Engagement	Oversees TN statewide decisions related to WBL; supervises Regional Leadership Team in building capacity of WBL Coordinators statewide; M.A., Austin Peay State University
Danesha Ward, TDOE Coordinator, College & Career Advising	Provides statewide guidance and resources to counselors working with students in postsecondary decision-making; Ed.D. (pending), Johns Hopkins University; M.A., University of Memphis
Dr. Ginger Stoker, AIR Senior Researcher	Experience as Principal Investigator on multiple EIR projects; WWC-certified reviewer; expert in college and career readiness, dual enrollment, and CTE; Ph.D., University of Chicago
Dr. Helen Duffy, AIR Senior Researcher	Expert researcher in college and career readiness, career pathways and workforce development, and qualitative methods; previously served as Deputy Director of the College and Career Readiness and Success Center at AIR; Ph.D., U.C. Berkeley, School of Education
Dr. Alexandria Radford, AIR Managing Researcher	Director, Center for Applied Research in Postsecondary Education; expertise in quantitative and qualitative studies and evaluations on postsecondary persistence and attainment and transitions into and out of postsecondary education; Ph.D., Princeton University

B4. Feedback & Continuous Improvement. All Project partners are committed to ensuring feedback and continuous improvement through (1) the Project's yearly formative evaluation structure and (2) regular communications, ongoing collaboration, and routines for seeking and using feedback, input, and data to strengthen the Project's operations.

The JFF **Technical Assistance Team** will hold biweekly videoconference meetings with the TDOE Technical Assistance team to discuss and address project management and implementation issues. The **Project Leadership Team** will meet monthly with AIR via videoconference to review progress towards goals, objectives, and outcomes and to make any mid-course corrections to implementation informed by formative evaluation data and Project input and feedback. A **Project community of practice (CoP)** will virtually convene biannually, sharing successes and challenges and discussing feedback for improvement; ***feedback surveys*** will be administered during the convenings. Other feedback will include at least once monthly

formal and informal inquiry processes with all Project schools, seeking their feedback regarding any barriers or difficulties experienced in implementation, as well as recommendations for improvement; a ***quarterly email update to all Project schools and partners***, providing updates and welcoming feedback; and ***using a "+/Δ" protocol*** after all site visits, technical assistance sessions, and formal meetings during which participants will briefly brainstorm what went well ("+") and what could be changed and improved ("Δ") to inform future work.

AIR will conduct a **formative evaluation each year** to provide the Project Leadership Team with extant data analysis to be used to determine whether the project is meeting its quantitative performance measures, as well as information regarding how schools are implementing the program. Each year's formative evaluation will create feedback that informs real-time improvements or improvements for the next year. Routines for gathering feedback and deciding on improvements will be integrated into ***monthly implementation review meetings***. Each meeting will include a regular agenda item to discuss feedback and implications for improving the project's strategies and procedures, and AIR will provide updates to the project team on information from school site visits conducted. AIR will also provide an update memo for ***bimonthly impact evaluation reviews*** to discuss real-time data analysis of progress and to inform federal reporting on the Project. Finally, AIR will hold an ***annual all-partner summative evaluation meeting*** to review and discuss the annual evaluation report.

B5. Dissemination. Scaling across multiple geographies in TN represents a critical opportunity to generate proof points and lessons that can be replicated and adaptively integrated nationwide. The Project partners will codify and disseminate information and strategies to support education systems in other states to implement key elements of WBC. The Project will bring to this approach a Project CoP that will surface common challenges and best practices, and we will document these challenges and successes in publications such as case studies, policy briefs, reports, and blogs. As noted, JFF will create a publicly available WBC blueprint, which will provide a clear framework for blending STEM/CS EPSOs and WBL to improve outcomes for high-need students. Project partners will present at relevant national conferences (e.g., on DE, STEM education, WBL, and college and career pathways). Finally, AIR's evaluation will build knowledge of how WBC create better outcomes for students, the core program elements needed for success, and the differing effects of those elements on key subgroups of high-need students. See Goal 3 in Tables 1 and 2 for additional details on the Project dissemination activities.

The Project partners are in an extremely strong position to disseminate these products and learnings. JFF is a national leader in the DE, WBL, and college and career pathways movements and will share and leverage the lessons learned from the Project with its network of schools, institutional- and system-level partners, and policymakers across 40+ states. JFF will also disseminate learnings, tools, and resources through its frequently visited websites (e.g., www.jff.org, www.ptopnetwork.org) and via the PtoP Network, the College in High School Alliance—a coalition of 80+ national and state organizations committed to policies that support high-quality DE and other EPSOs—and the Center for Apprenticeship and WBL. As TN's state education agency, TDOE is uniquely well positioned to disseminate lessons learned and support statewide replication and scale, and the Project will serve as the foundation for an innovative high school model that will be scaled across TN. To support the development of the Project, TDOE will disseminate best practices and lessons learned through guidance to schools and districts across TN. AIR, a nationally recognized leader in research and evaluation, will design the evaluation to highlight and support effective replication of the Project's core elements.

C. QUALITY OF THE PROJECT EVALUATION

AIR will conduct a rigorous, independent evaluation of the Project that will (1) provide formative feedback to guide program development, (2) measure the extent to which the Project is implemented as intended, and (3) estimate the impact of the Project on students' college and career readiness, STEM/CS outcomes, and college and career outcomes. The implementation study will support continuous improvement by providing early feedback to refine program components and produce measures of fidelity of implementation. A complete timeline of evaluation activities is included in Appendix I. **The impact study will use a rigorous quasi-experimental design specified to meet What Works Clearinghouse (WWC) standards with reservations**. The evaluation will address the five research questions shown in Table 4.

Table 4. Research Questions

Type	Research Question
Confirmatory	1. What is the effect on the Project on students' college and career readiness?
	2. What is the effect of the Project on students' STEM/CS outcomes?
	3. What is the effect of the Project on students' college and career outcomes?
Moderation	4. Is the effect of the Project on students' college and career readiness, STEM/CS outcomes, and college and career outcomes moderated by student characteristics?
Implementation	5. To what extent is the Project implemented as intended? What obstacles inhibit, and what factors enable, successful implementation of the Project?
Mediation	6. To what extent do program components mediate the impact of the Project on students' college and career readiness, STEM/CS outcomes, and college and career outcomes?

C1. Evaluation Methods Designed to Meet WWC Evidence Standards With Reservations

Impact Evaluation: Research questions 1-3, impact estimates. Beginning in year 3, AIR will conduct a rigorous quasi-experimental design study designed to **meet WWC standards with reservations** (see Evaluation Timeline in Appendix I). The impact study, which will be used to address research questions 1, 2, and 3, will examine the effect of the Project on students' college and career readiness, STEM/CS outcomes, and college and career outcomes (Table 5).[53] **All outcome measures meet WWC face validity and reliability requirements**.

Table 5. Impact Evaluation Outcomes

WWC Domain	Outcomes	Grade 11	Grade 12	Post-secondary
College and career readiness				
Student engagement in school	Student attendance	X	X	
Secondary school academic achievement	ACT composite score[54]		X	
Completing high school	High school graduation		X	
STEM/Computer Science (CS)				
General science achievement	ACT science subscore		X	
General mathematics achievement	ACT mathematics subscore		X	
Progressing in college	Number of STEM/CS early postsecondary (EPSO) (i.e., dual enrollment, dual credit course, or AP) credits earned	X	X	
College and career outcomes				
College enrollment	College enrollment (i.e., two-year or four-year) fall after graduation			X
Industry-recognized credential, Certificate or license	Completion of a STEM/CS industry-recognized credential, Certificate or license		X	

All student-level outcomes, prior academic achievement, demographic, and background characteristics data, as well as school characteristics (e.g., percentage Black and Hispanic students, school-level achievement, district), will be obtained from TDOE.

The impact study will include two cohorts of schools. Each cohort will include 10 treatment schools and 10 comparison schools, for a total for 20 treatment and 20 comparison schools (see *Quality of Project Design*). Treatment students will be all grade 11 students completing a STEM/CS pathway aligned with WBCs in high schools participating in the Project in the 2022-23 (cohort 1) and 2023-24 (cohort 2) school years. Comparison students will be grade 11 students completing the same STEM/CS pathways in similar high schools that are not participating in the Project in the same school years and districts.[55] Treatment and comparison students will be followed to grade 12 and postsecondary.

AIR will assess baseline equivalence of students in the treatment and comparison groups for all impact analyses using measures of prior academic achievement (i.e., Tennessee Comprehensive Assessment Program (TCAP) end-of-course (EOC) assessments in English II and Algebra I) and student-level free and reduced-price lunch status.[56,57] AIR will assess whether treatment and control conditions differ using WWC standards.[58] In accordance with WWC standards, baseline equivalence will estimated for each outcome analysis. To increase precision in estimating the impact of the program on outcomes, the analytic models will include all student baseline covariates and demographic characteristics, regardless of whether the standardized mean difference meets the WWC threshold for inclusion in analytic models (i.e., standardized mean difference is >0.05 but <0.25).

If baseline equivalence is not met for one or more baseline measures, AIR will use propensity score weighting to account for selection bias and baseline equivalence will be reassessed using the weights.[59] An advantage of propensity score weighting is that all individuals in the sample are used, unlike matching. AIR will use the following equation to estimate propensity scores: Logit (Z_i)= $\alpha + X'_i\beta$, where Z_i indicates the treatment status for student *i* (Z_i= 1 for students in treatment schools, and Z_i= 0 for students in comparison schools), and X'_i is vector of individual student characteristics (i.e., TCAP EOC scores in Algebra I, English II, gender, race/ethnicity, free or reduced-price lunch status, special education status).

AIR will use two-level, hierarchical models (linear for continuous outcomes or general linear models for binary outcomes), with students nested within schools to estimate the treatment effects.[60] The model for continuous outcomes is:

$$Y_{ij} = \gamma_{00} + \gamma_{01}(Treat)_j + \sum_{m=2}^{M} \gamma_{0m}(School)_j + \sum_{n=1}^{N} \gamma_{1n}(Student)_{ij} + u_{0j} + r_{ij}$$

Where Y_{ij} is the student-level outcome, $Treat_j$ is a school-level, binary treatment indicator; $School_j$ is a vector of grand-mean centered school-level characteristics, including percent Black and Hispanic students, average school achievement, district fixed effects and a cohort indicator; and $Student_{ij}$ is a set of grand-mean centered student-level characteristics, including prior achievement, free or reduced-price lunch status, racial/ethnic group, gender, special education status, and English learner status. Logistic and Poisson functions will be applied for binary and count outcomes. Complete case analysis will be used to handle missing data.

Research question 4, moderation analyses. To address research question 4, moderation analyses will be conducted to assess the extent to which the Project has a different impact on subgroups of students. In line with Project goals, AIR will conduct moderation analyses to determine whether the program as a differential effect for Black and Latinx students and female students. To conduct moderation analyses, the impact analysis models will be modified by adding interactions with treatment indicators to the analytic model.

Power analyses for student outcomes. The minimum detectable effect size (MDES) for the student outcomes analyses is 0.19. This MDES assumes an average of 60 grade 11 students per school in each of the 20 treatment and 20 comparison schools, that 5% of the variation in student outcomes is between schools, that student prior achievement and background covariates account for 50% of the student-level variation in outcomes, and that school characteristics explain 25% of the variation in between-school variation.[61]

C2. Key Project Components and Measurable Threshold for Implementation

Implementation Study: Research question 5, implementation. To answer research question 5, AIR will assess program implementation across study sites. The design of the evaluation is informed by clearly articulated key project components, mediators, and outcomes of the Project as depicted in the logic model (see Section A. Quality of Project Design). During each implementation year, AIR will collect formative data on key project components through school site visits and teacher surveys.[62] During school site visits, AIR will conduct interviews with teachers, STEM/CS advisors, and school administrators to gather information about professional development and training, implementation of strategic alliances with postsecondary partners and local business leaders, STEM/CS advising and academic supports, implementation of WBCs and work-based learning, participation in Project communities of practice, and obstacles that inhibit and factors that facilitate successful implementation. AIR will also administer surveys to students enrolled in the STEM/CS pathway aligned with WBC to collect information on students' experiences with STEM/CS advising, STEM/CS career counseling, and the newly developed WBC. AIR will also conduct focus groups with up to 10 students participating in the Project.[63] Focus groups will cover similar topics as the survey but will allow students to expand upon their answers and provide greater detail. In addition, AIR will administer a teacher survey to WBC teachers and their business partners to gather information on instructional strategies, co-implementation of WBC, and feedback on the Project professional development and training, tools, and materials. Finally, AIR will collect attendance logs from professional development and training sessions as well as CoP meetings. AIR will use these results to provide continuous feedback to project team leaders during monthly implementation calls, formative feedback presentations, and the annual evaluation reports. Data from the formative evaluation can also be used to foster sustainability and guide replication of the Project in other settings. AIR will work with the project team to finalize a **measurable threshold for acceptable implementation** before collecting implementation data. The key components and the preliminary thresholds for acceptable implementation of these components are shown in Table 6.

Table 6. Key Components and Thresholds for Acceptable Implementation

Components	Threshold	Data Source
Component 1: Professional Development and Training		
Professional development focused on WBC blueprints	All WBC teachers attend professional development focused on implementing WBC blueprints.	Attendance logs Teacher interviews Teacher surveys
STEM advising training	At least one advisor in each school is trained to provide STEM/CS-focused course advising and career advising	Attendance logs Advisor interviews
Component 2. Strategic Partnerships		
Strategic alliances with postsecondary partner(s)	Schools develop a partnership with at least one postsecondary partner to facilitate WBC.	School administrator and teacher interviews
Strategic alliances with local businesses	Schools develop partnerships with at least one local business to co-develop and implement WBC and offer work-based learning opportunities.	School administrator and teacher interviews
Component 3. STEM/CS Course Advising, Career Counseling, and Academic Supports		
STEM/CS course advising	At least 80% of students participate in at least one 1:1 STEM/CS course advising session each year.	Advisor interviews Student focus groups Student surveys
STEM/CS career supports	At least 80% of students participate in at least one advising session focused on career options, prerequisites and works skills.	Advisor interviews Student focus groups Student surveys
STEM/CS academic supports	At least 80% of students receive information and support from teachers or advisors regarding skills to support WBC.	Student focus groups Student surveys
Component 4: Work-based Courses with Work-based Learning (i.e., dual enrollment, dual credit, and AP courses)		
WBC course development	All WBC teachers co-design at least one course that has an embedded work-based learning component	Teacher interviews Teacher surveys
WBC course offerings	All schools offer WBC with work-based learning components	School administrator teacher interviews
WBC course enrollment	At least 60 students per school per cohort enroll in WBC course in grades 11 and 12	Student data
Component 5: Communities of Practices		
Participation in CoP	WBC teachers participate in at least two community of practice meetings per year	Attendance logs Teacher interviews

<u>*Research question 6, mediation analyses.*</u> AIR will conduct mediation analyses to understand which specific program components are related to overall Project impacts. To answer research question 6, if the study detects statistically significant impacts of the Project on students' STEM

outcomes or college and career readiness, AIR will implement the multilevel modeling procedures outlined in Krull & MacKinnon (2001) will to identify which program components are related to project outcomes.[64] These models will estimate the proportion of the impact of the Project on key outcomes that is mediated through each of the measured program components.

C3. Extent to which Methods of Evaluation will Provide Performance Feedback and Permit Periodic Assessment of Progress Toward Achieving Intended Outcomes. In addition to assessing progress toward achieving project goals and objectives as measured by the performance measures to be included in the annual performance report (see *Quality of Project Design*), AIR will meet monthly with the project leadership team monthly to provide timely performance feedback on the evaluation activities and findings. During these meetings, AIR will discuss progress toward developing data collection protocols, conducting site visits, cleaning and analyzing implementation and impact data, initial findings, and any challenges encountered during the prior month. In addition, AIR will hold an annual, formative feedback meeting with project leadership. The meeting will be held at the end of the summer, prior to the start of the upcoming school year. During this meeting, AIR will summarize key findings from teacher surveys and site visits, including summaries of findings from interviews, focus groups, and surveys. The goal of this meeting is to provide the project leadership team with formative feedback from the prior school year that can be used to introduce any necessary changes to program implementation during the upcoming school year. Finally, each year, AIR will provide the project team with a formal, annual evaluation report. These evaluation reports will include quantitative findings from the impact, moderator, and mediator analyses, as available, as well as detailed information on fidelity of implementation.

D. PROJECT NARRATIVE REFERENCES

[1] What Works Clearinghouse, Institute of Education Sciences. 2017. Dual Enrollment Programs. U.S. Department of Education. https://ies.ed.gov/ncee/wwc/Docs/InterventionReports/wwc_dual_enrollment_022817.pdf
[2] TN ED Equity. *Early Post-Secondary Opportunities in Tennessee.* https://journals.sagepub.com/doi/pdf/10.1177/2158244016682996
[3] Ibid.
[4] Rogers-Chapman M.F. and Darling-Hammond L. 2013. *Preparing 21st Century Citizens: The Role of Work-Based Learning in Linked Learning*. Stanford Center for Opportunity Policy in Education. https://edpolicy.stanford.edu/sites/default/files/publications/preparing-21st-century-citizens-role-work-based- learning-linked-learning.pdf
[5] Lippman L. H., Ryberg R., Carney R., Moore K. A. 2015. *Key "Soft Skills" That Foster Youth Workforce Success: Workforce Connections: Toward a Consensus Across Fields.* Child Trends. https://www.childtrends.org/wp-content/uploads/2015/06/2015-24WFCSoftSkills1.pdf
[6] Ross M., Anderson Moore K., Murphy K., Bateman N., DeMand A., Sacks V. 2018. *Pathways to High-Quality Jobs for Young Adults.* Child Trends. https://www.brookings.edu/wp-content/uploads/2018/10/Brookings_Child-Trends_Executive-Summary-FINAL.pdf
[7] Kobes D. 2016. *Work-Based Courses Project Outcomes Report*. Jobs for the Future.
[8] Tennessee Department of Education. 2020. *Tennessee Computer Science Education Plan.* https://www.tn.gov/content/dam/tn/education/ccte/cte/FINAL_ComputerSciencePC454.pdf
[9] Tennessee Department of Labor and Workforce Development. 2019. *The Demand for STEM Occupations in Tennessee.* https://www.jobs4tn.gov/admin/gsipub/htmlarea/uploads/LMI/Publications/STEMReport2019Updated.pdf
[10] Code.org. *Support K-12 Computer Science Education in Tennessee*. https://code.org/advocacy/state-facts/TN.pdf
[11] Tennessee Department of Labor and Workforce Development. 2019. *The Demand for STEM Occupations in Tennessee.* https://www.jobs4tn.gov/admin/gsipub/htmlarea/uploads/LMI/Publications/STEMReport2019Updated.pdf
[12] Funk C., Parker K. 2018. *Women and Men in STEM Often at Odds Over Workplace Equity*. Pew Research Center. https://www.pewsocialtrends.org/2018/01/09/diversity-in-the-stem-workforce-varies-widely-across-jobs/
[13] Ibid.
[14] Code.org. *Support K-12 Computer Science Education in Tennessee.* https://code.org/advocacy/state-facts/TN.pdf
[15] The College System of Tennessee. "Fall Enrollment of Top Program Areas." https://app.powerbi.com/view?r=eyJrIjoiYWQ1YmFiYWEtYjY5NC00MzI1LThlOTgtYzk5ZGY2MzU2N2VjIiwidCI6Ijc4ZTkwNWIzLTE4ZWEtNGE5MS04YjlmLTMzZTRmZTNjYTQ4YSIsImMiOjN9
[16] Tennessee Department of Education. 2020. *Tennessee Computer Science Education Plan.* https://www.tn.gov/content/dam/tn/education/ccte/cte/FINAL_ComputerSciencePC454.pdf
[17] Tennessee Department of Education. 2019. "TN Graduation Rate Continues to Rise." https://www.tn.gov/education/news/2019/9/16/tn-graduation-rate-continues-to-rise.html

[18] Ibid.
[19] TN Department of Education. *Drive to 55: Pathways to Postsecondary Report.* https://www.tn.gov/content/dam/tn/education/ccte/ccte_drive_to_55_report_state.pdf
[20] Ibid.
[21] The College System of Tennessee. 2019. *Two-Year Advising: What's in the Data Toolbox?* https://www.tbr.edu/sites/default/files/media/2019/03/Advising%20Academy%20Master%20Presentation_0.pdf
[22] Code.org. *Support K-12 Computer Science Education in Tennessee*. https://code.org/advocacy/state-facts/TN.pdf
[23] State Collaborative on Reforming Education. 2020. *SCORE Report: Advising Students Toward Opportunity*. https://tnscore.org/wp-content/uploads/2019/12/Advising-Students-Toward-Opportunity.pdf
[24] TN ED Equity. *Early Post-Secondary Opportunities in Tennessee.* https://journals.sagepub.com/doi/pdf/10.1177/2158244016682996
[25] Ibid.
[26] Tennessee Department of Education. 2020. Work-Based Learning Enrollment in Tennessee. https://jobsforthefuture552-my.sharepoint.com/:x:/g/personal/jmawhinney_jff_org/EaNB4ti1tMJDtb5fzarCv9MBbRfxiSUgkFcCtk_3tdJMYg?e=gsGHqQ
[27] TN ED Equity. *Early Post-Secondary Opportunities in Tennessee.* https://journals.sagepub.com/doi/pdf/10.1177/2158244016682996
[28] Ibid.
[29] TN Department of Education. *Drive to 55: Pathways to Postsecondary Report.* https://www.tn.gov/content/dam/tn/education/ccte/ccte_drive_to_55_report_state.pdf
[30] What Works Clearinghouse, Institute of Education Sciences. 2017. Dual Enrollment Programs. U.S. Department of Education. https://ies.ed.gov/ncee/wwc/Docs/InterventionReports/wwc_dual_enrollment_022817.pdf
[31] Ibid.
[32] Warner, M., Caspary, K., Arshan, N., Stites, R., Padilla, C., Patel, D., McCracken, M., Harless, E., Park, C., Fahimuddin, L., & Adelman, N. (2016). *Taking stock of the California Linked Learning District Initiative. Seventh-year evaluation report.* SRI International. https://www.sri.com/work/publications/taking-stockcalifornia-linked-learning-district-initiative-seventh-year
[33] Klopfenstein, K. 2010. *Does the Advanced Placement Program Save Taxpayers Money? The Effect of AP Participation on Time to College Graduation*. Texas Christian University.
[34] Shelton, G. 2020. *EPSOs in Action*. TN Education Research Alliance. https://peabody.vanderbilt.edu/TERA/files/22035_EPSOs_in_Action_Brief.pdf
[35] TN ED Equity. *Early Post-Secondary Opportunities in Tennessee.* https://journals.sagepub.com/doi/pdf/10.1177/2158244016682996
[36] Challenge Success. 2013. The Advanced Placement Program: Living Up to Its Promise? https://www.challengesuccess.org/wp-content/uploads/2016/11/ChallengeSuccess-AdvancedPlacement-WP.pdf
[37] Klopfenstein, K. 2010. *Does the Advanced Placement Program Save Taxpayers Money? The Effect of AP Participation on Time to College Graduation*. Texas Christian University.

[38] Rogers-Chapman, M.F. and Darling-Hammond, L. 2013. *Preparing 21st Century Citizens: The Role of Work-Based Learning in Linked Learning*. Stanford Center for Opportunity Policy in Education. https://edpolicy.stanford.edu/sites/default/files/publications/preparing-21st-century-citizens-role-work-based- learning-linked-learning.pdf
[39] Center for Advanced Research and Technology (CART). 2011. *A Model for Success: CART's Linked Learning Program Increases College Enrollment.* https://irvine-dot-org.s3.amazonaws.com/documents/60/attachments/cart_findings_report_final.pdf?1416865594
[40] Lippman L. H., Ryberg R., Carney R., Moore K. A. 2015. *Key "Soft Skills" That Foster Youth Workforce Success: Workforce Connections: Toward a Consensus Across Fields.* Child Trends. https://www.childtrends.org/wp-content/uploads/2015/06/2015-24WFCSoftSkills1.pdf
[41] Ross M., Anderson Moore K., Murphy K., Bateman N., DeMand A., Sacks V. 2018. *Pathways to High-Quality Jobs for Young Adults.* Child Trends. https://www.brookings.edu/wp-content/uploads/2018/10/Brookings_Child-Trends_Executive-Summary-FINAL.pdf
[42] Seymour S., Ray J. 2014. *Useful Internships Improve Grads' Chance of Full-Time Work.* Gallup. https://news.gallup.com/poll/179516/useful-internships-improve-grads-chances-full-time-work.aspx;
Carnevale A., Smith N., Melton M., Price E. 2015. Learning While Earning: The New Normal. Georgetown University Center on Education and the Workforce. https://cew.georgetown.edu/wp-content/uploads/Working-Learners-Report.pdf
[43] Kobes D. 2016. *Work-Based Courses Project Outcomes Report*. Jobs for the Future.
[44] Ibid.
[45] Tennessee Department of Education. "Tennessee Pathways." https://www.tn.gov/education/pathwaystn.html
[46] Tennessee Code Title 49 – Education Chapter 15. 2010. Tennessee Code Ann. §49-15-101 https://law.justia.com/codes/tennessee/2010/title-49/chapter-15/49-15-101/
[47] Tennessee Department of Education. 2020. *Tennessee Computer Science State Education Plan.* https://www.tn.gov/content/dam/tn/education/ccte/cte/FINAL_ComputerSciencePC454.pdf
[48] Tennessee Department of Education. 2020. "TDOE Announces New STEM Designated Schools Will Receive $10K Award from Governor Lee's Future Workforce Initiative." https://www.tn.gov/education/news/2020/5/11/tdoe-announces-new-stem-designated-schools-will-receive--10k-award-from-governor-lee-s-future-workforce-initiative.html
[49] Code.org Advocacy Coalition. 2018. *State of Computer Science Education: Policy and Implementation.* https://code.org/files/2018_state_of_cs.pdf
[50] Collins, E., Schaaf, K. 2020. *Teacher Retention in Tennessee.* Tennessee Department of Education. https://www.tn.gov/content/dam/tn/education/reports/TeacherRetentionReportFINAL.pdf
[51] Ibid.
[52] The American School Counselor Association (ASCA) recommends a counselor to student ratio of 1:250. The national counselor to student ratio is 1:464. For Tennessee, this ratio is 1:336.
[53] For information on WWC domains, see WWC Review of Individual Studies Protocol, Version 4.0 (May 2019) https://ies.ed.gov/ncee/wwc/Docs/ReferenceResources/wwc_ris_protocol_v4.pdf
[54] All high school students in Tennessee are required to complete the SAT or ACT. Most students complete the ACT as districts in Tennessee contract with ACT to take the assessment

during the school day at no cost to the student. However, if a student only has an SAT score, it will be converted to an ACT score.

[55] Comparison high schools will be selected based on student demographic and achievement profiles. All comparison high schools will offer the same STEM/CS pathways offered in treatment schools. Comparison schools will continue business-as-usual.

[56] What Works Clearinghouse. 2020. *Standards Handbook, Version 4.1*. Washington, DC: U.S. Department of Education, Institute of Education Sciences.

[57] To meet baseline equivalence if no direct premeasure exists, baseline equivalence should be demonstrated using standard measures of academic readiness or skills and socio-economic status (e.g., free or reduced-price lunch status). See baseline equivalence in WWC Review of Individual Studies Protocol, Version 4.0 (May 2019) https://ies.ed.gov/ncee/wwc/Docs/ReferenceResources/wwc_ris_protocol_v4.pdf

[58] For continuous outcomes, the WWC uses the Hedges' *g*, with an adjustment for small sample bias. For dichotomous, the WWC uses the Cox index to determine these effect sizes. The WWC considers groups to be equivalent if the effect size differences are less than 0.05. If effect size differences are greater than 0.05 but less than 0.25, the WWC requires inclusion of the variables in the analytic models as covariates. If effect size differences are greater than 0.25, the WWC does not consider the groups to be equivalent.

[59] Guo, S. & Fraser, M. 2015. *Propensity Score Analysis: Statistical Methods and Applications* (2nd ed). Thousand Oaks, CA: Sage Publications, Inc.

[60] If propensity score weighting is used, these will be included in the outcomes analyses.

[61] It is expected that schools will develop at least two STEM/CS WBC courses to be offered to students in grade 11 and 12. It is expected that at least 30 students will enroll in at least one of the courses in grade 11 and 12 (2 courses per year X 30 students per course = 60 students).

[62] AIR will develop and finalize all data collection protocols during year 1 in coordination with the project team. All protocols will receive IRB approval prior to administration.

[63] AIR will collect signed parent consent forms from students participating in the focus groups. Survey opt-out forms will be sent home with students one-week prior to survey administration. Students brining back signed opt-out forms will not complete the student survey.

[64] Krull, J. & MacKinnon, D. 2001. Multilevel modeling of individual and group level mediated effects. *Multivariate Behavioral Research, 36*(2), 249-277.