CompuPower Investing in Innovation Evaluation

Final Report

Peggy Clements, Amelia Auchstetter, Shuqiong Lin, and Corey Savage

JUNE 2022

Advancing Evidence.
Improving Lives.

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18318_06/22

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Acknowledgments

Even during a typical school year, an evaluation such as this one requires the support and collaboration of many individuals and institutions. Given the COVID-19 pandemic, the 2019–20 and 2020–21 school years were not typical, and the authors deeply appreciates the students, teachers, school support staff, and principals who participated in or supported data collection activities under difficult circumstances.

We want to acknowledge the U.S. Department of Education's Investing in Innovation (i3) program for its financial support. The i3 development grant awarded to Arizona State University (ASU) enabled the ASU Center for Gender Equity in Science and Technology (ASU CGEST) to implement the CompuPower program in the schools that participated in this evaluation, as well as schools that participated during the pilot years. The grant also paid for all data collection, analysis, and reporting activities.

We thank Abt Associates for their technical support throughout the design and execution of this evaluation, with particular thanks to Michelle Blocklin for her ongoing guidance. We also thank our colleague Jordan Rickles for his guidance and support throughout the project, including his expert review of the report.

Lastly, we thank Kimberly Scott and current and former ASU CGEST staff, including Tara Nkrumah, Elaine Arietta Bohn, Gabrielle Swindle, and Matthew Ruf. We have valued our partnership with them throughout this evaluation of their program, and appreciate the valuable program data and insights they provided. ASU CGEST staff worked incredibly hard to recruit and retain Cohort 2 schools after the onset of the COVID-19 pandemic. Their support was critical to maintaining the schools' engagement, compliance with study requirements, and support of the data collection activities.

This report was developed under Grant No. U411C10612 from the U.S. Department of Education. However, the contents to not necessarily represent the policy of the Department of Education, and one should not assume endorsement by the federal government.

Executive Summary

This is the final report of an independent evaluation of the CompuPower program developed by Kimberly Scott and her colleagues at the Arizona State University's Center for Gender Equity in Science and Technology (ASU CGEST). CompuPower is a multifaceted program for high school students centered on a culturally responsive computing course. CompuPower builds on another program, called CompuGirls, that Scott and her colleagues developed and studied for the past 20 years to address the underrepresentation of women of color in science, technology, engineering, and mathematics (STEM) fields. For this project, funded by a U.S. Department of Education Investing in Innovation (i3) development grant, Scott and her colleagues revised and expanded CompuGirls to develop a program for high school students of all genders.

What Is CompuPower?

The CompuPower program has four key components that build on theory and research to address the need for culturally responsive education practices. The central component of the program is the CompuPower culturally responsive computing curriculum, which is designed to be taught during a full academic year. The course emphasizes society, science, and technology as innovation drivers and provides opportunities for students to investigate their intersectional identities using technology tools and computational thinking. A second component is the professional development activities that ASU CGEST provides to the "mentor teachers" who deliver the CompuPower curriculum in participating schools. The professional development activities cover the rationale and methods for using culturally relevant and responsive teaching practices and introduce mentor teachers to the CompuPower curriculum. The third component is a multiday event, the CompuPower Residency Experience, in which students work collaboratively with each other and industry mentors while staying on the ASU campus. The fourth and final component is a series of parent workshops, the Parent Academy, which is designed to help parents support their children as they pursue STEM educational opportunities in high school and college. CompuPower's inclusion of various adults in students' lives—teachers, parents, and industry professionals—acknowledges that development occurs within and is influenced by the multiple settings that students encounter in their lives.

ASU CGEST designed CompuPower with the expectation that high school students' participation in the program would, in the short term, lead to increases in their self-regulation, critical thinking skills for everyday life, and academic achievement. CompuPower's theory of change proposes that these shorter term outcomes will lead to increased STEM and leadership competencies, and these competencies will lead students to become "technosocial change agents," which Scott and colleagues define as those who challenge dominant narratives and construct liberating social relations in the process of creating new technologies.

What Did the Evaluation Examine?

The American Institutes for Research® (AIR®) conducted an independent evaluation of CompuPower in nine mostly rural Arizona high schools. AIR conducted a 2-year evaluation, with five schools participating in the 2019–20 school year and six schools participating in 2020–21, including two that participated in the first year. The impact evaluation employed a quasi-experimental matched comparison design to estimate the impact of CompuPower on two measures of students' social emotional outcomes—self-regulation and critical thinking skills for everyday life—and their academic achievement as measured by their grade point average (GPA). The evaluation also assessed the implementation fidelity of the four key components of the CompuPower program.

What Did the Evaluation Find?

The results of the implementation evaluation indicated that of the four key program components, only the mentor teacher professional development was implemented with fidelity. Exhibit ES1 summarizes the results of the implementation evaluation. ASU CGEST developed and offered the mentor teacher professional development in both years of the evaluation and was able to transition from in-person to virtual training when the COVID-19 pandemic hit in spring 2020, with most mentor teachers consistently participating in the activities. Most of the implementation challenges to the other three program components resulted from the COVID-19 pandemic, but there were other challenges as well. In both years of the study, the pandemic disrupted the CompuPower course through school closures or other interruptions to the class, which contributed to some teachers not covering all of the course content. The pandemic also interrupted the CompuPower Residency Experience. ASU CGEST could not hold an in-person multiday CompuPower Residency Experience in either year of the project, although they worked hard to provide students with virtual activities instead. In addition, ASU CGEST reported that the stressors experienced by its industry partners prevented the involvement of industry mentors in the program as planned. Finally, the Parent Academy workshops were not offered in either year because it was not possible to find community volunteers who could commit to the time and travel necessary to participate in the required training for presenting the workshops.

Exhibit ES1. Summary of the Implementation Findings for the Four Key CompuPower Program Components

CompuPower key component	Definition of adequate implementation	Cohort 1: Implemented with adequate fidelity	Cohort 2: Implemented with adequate fidelity	Cohorts 1 and 2 combined: Implemented with adequate fidelity
CompuPower course curriculum	For each class, teachers deliver more than 80% of the lessons and assign more than 80% of the student deliverables.	No	No	No
Mentor teacher professional development	Each mentor teacher participates in the summer professional development workshop, completes the asynchronous online activities, and participates in at least half of the quarterly activities.[a]	Yes	Yes	Yes
CompuPower Residency Experience	Each industry mentor participates in all days of the CompuPower Residency Experience. Each student participates in the full CompuPower Residency Experience and submits a capstone project.	No	No	No
Parent Academy	For each student, a parent or guardian attends six of the seven 2-hour Parent Academy sessions.	No	No	No

Note. Data are based on the authors' analysis of program data collected by ASU CGEST and AIR-administered teacher survey data.

[a] For Cohort 1, the quarterly activities were the informal one-on-one check-ins with an ASU CGEST staff member. For Cohort 2, the quarterly activities were participating in a formal 3-hour virtual professional development session.

To conduct the impact evaluation that examined the effectiveness of the CompuPower program, AIR first conducted propensity score matching to match students who participated in CompuPower (treatment group students) with comparison group students who participated in the study during the same school year; were in the same grade level; and who shared similar demographic characteristics, performance on the pretest measures of the outcomes, and school characteristics. The CompuPower students and the matched comparison group students formed the analytic sample that AIR used for the impact analyses.

The impact evaluation investigated one confirmatory research question:

1. Did the CompuPower program have an effect on students' self-regulation?

This confirmatory research question addresses the outcome that ASU CGEST considered the essential social-emotional outcome for CompuPower of the two we examined.

The impact evaluation also answered two exploratory questions, one addressing an additional social-emotional outcome and the other addressing an academic achievement outcome:

2. Did the CompuPower program have an effect on students' critical thinking skills for everyday life?
3. Did the CompuPower program have an effect on students' grade point average?

To answer these research questions, AIR used a separate two-level linear model for each outcome, controlling for student background characteristics, pretest measures, and school characteristics. As shown in Exhibit ES2, CompuPower students showed slightly higher scores on self-regulation, critical thinking skills for everyday life, and GPA measures than the comparison students, but the differences were not statistically significant.

Exhibit ES2. Differences in Student Social-Emotional and Academic Achievement Outcomes

Outcome measure	Comparison group			CompuPower group			CompuPower – comparison difference	Hedges' *g*	*p* value
	Sample size	Mean	*SD*	Sample size	Model-adjusted mean	*SD*			
Adolescent self-regulation	62	0.94	1.06	161	1.11	1.40	0.17	0.14	0.25
Critical thinking skills for everyday life	62	1.01	0.97	161	1.21	1.34	0.20	0.19	0.16
GPA	61	3.03	0.85	152	3.12	0.64	0.09	0.11	0.32

Note. *SD* = standard deviation. Data based on authors' analysis based of AIR-administered student surveys and school-provided administrative data.

What Do the Results Mean?

Given the significant challenges to implementing the CompuPower program because of the COVID-19 pandemic, it is difficult to draw definitive conclusions about the program's effectiveness. Although the results of the impact analyses were not statistically significant, it is important to place these results in the context of program implementation, with only one of the four key components implemented with fidelity. That the differences between the CompuPower and comparison groups were consistently positive under these circumstances suggests the possibility that CompuPower could lead to improved outcomes for students if the full program were implemented with fidelity. In addition, the student sample was smaller than planned given difficulties obtaining parental consent and collecting student data, which reduced our statistical power to detect statistical significance. Future research with full implementation of the full program and a larger sample is warranted to better determine the program's effectiveness.

Introduction

CompuPower is a multifaceted program for high school students centered on a culturally responsive computing course. The program builds on an earlier program, called CompuGirls, that Kimberly Scott and her colleagues developed and studied for the past 20 years (Scott et al., 2009; Scott et al., 2015; Scott & White, 2013). Scott developed CompuGirls to address the underrepresentation of women of color in science, technology, engineering, and mathematics (STEM) fields. She recognized that girls of color attend schools that may not encourage their interests in STEM or prepare them for work in STEM careers. By offering these girls the opportunity to participate in a summer or afterschool culturally responsive technology program, CompuGirls allows girls to engage in activities that increase their understanding of STEM-related topics while helping them develop social-emotional skills that they can draw on as they pursue their interests in STEM (Scantlebury & Baker, 2007; Scott et al., 2009).

For this project, Scott and her colleagues at Arizona State University's Center for Gender Equity in Science and Technology (ASU CGEST) revised and expanded CompuGirls to develop a program for high school students of all genders. CompuPower's primary short-term goals are to develop students' social-emotional skills—such as self-regulation—as they also develop skills for using technology for research and problem solving. The expectation is that improving students' social-emotional skills will help them pursue and be successful in STEM-related fields and ultimately become changemakers in their communities. As described in greater detail in the next section, CompuPower works to achieve these goals by providing students with a culturally responsive computing course and other activities, as well as training and support for important adults in these students' lives to help the adults work with the students in constructive ways. Building on the U.S. Department of Education's Investing in Innovation (i3) program's commitment to expand rural students' access to innovative educational programs, ASU CGEST elected to conduct the project in primarily rural schools. This focus on rural students builds on ASU CGEST's commitment to providing students who are underrepresented in STEM fields with opportunities to explore STEM-related concepts in culturally responsive settings where they are supported by adults who recognize students' strengths and assets.

Funded by an i3 development grant to develop and evaluate an innovative program that influences the development of noncognitive or social-emotional skills,[1] researchers at the American Institutes for Research (AIR) conducted an independent external evaluation of CompuPower to examine whether students' participation in the program improved their social-

[1] This i3 project addressed two absolute priorities listed in the notice inviting applications (Department of Education Notice of Applications for New Awards, 2016): Influencing the Development of Non-Cognitive Factors (Absolute Priority 4) and Serving Rural Communities (Absolute Priority 5).

emotional skills and academic achievement and whether the program was implemented as designed. The evaluation focused on nine mostly rural Arizona high schools that offered the CompuPower program in the 2019–20 or 2020–21 school year. In addition to investigating the impact of the CompuPower program, the evaluation also contributes empirical evidence to the field about the causal impact of culturally responsive education programs on students' academic and nonacademic outcomes.

This report begins by describing the CompuPower program, including a section on culturally responsive computing. Subsequent sections present the evaluation design, how the CompuPower program was implemented, and differences in the outcomes of CompuPower students and students in the comparison group on their social emotional and academic outcomes. The report concludes with a section on study limitations and a discussion of the results.

Overview of the CompuPower Program

Scott and her ASU CGEST colleagues built on theory and research on culturally responsive educational practices to design the four key components of the CompuPower program. The central component is the curriculum for the culturally responsive computing course. In addition to the course, CompuPower also provides professional learning experiences to prepare mentor teachers to deliver the CompuPower curriculum, a multiday residential learning experience in which students work collaboratively with each other and industry mentors on the ASU campus, and a series of parent workshops designed to help parents support their children as they pursue STEM opportunities. CompuPower's inclusion of various adults in students' lives—teachers, parents, and industry professionals—acknowledges that development occurs within and is influenced by the multiple settings in which students live (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 1998). The program provides training and information to important adults in students' lives to help the adults support students as they complete high school and transition into college.

CompuPower's theory of change proposes that high school students' participation in the program will, in the short term, lead to increases in their self-regulation, critical thinking skills for everyday life, and academic achievement. The theory of change goes on to propose that these shorter term outcomes will lead to increased STEM and leadership competencies, and these competencies will lead students to become "technosocial change agents." Scott and colleagues define technosocial change agents as individuals who can "challenge dominant narratives and construct more liberating identities and social relations as they create new technologies" (Ashcraft et al., 2017, p. 234). See Appendix A for a logic model that illustrates the hypothesized relationships between the program components and the short- and long-term outcomes.

This section begins with an overview of culturally responsive education theory and research and its application to computing-related instruction and then describes the four core components of the CompuPower program.

Culturally Responsive Computing

In the past several decades, researchers have developed and refined theoretical frameworks that address cultural responsiveness in education. The two most well-known frameworks are culturally relevant pedagogy (Ladson-Billings, 1995b) and culturally responsive teaching (Gay, 2002, 2018). Culturally relevant pedagogy is based on three overall goals for teaching: promote academic success, help students foster positive ethnic and cultural identities, and support the development of sociopolitical consciousness (Ladson-Billings, 1995a). Similarly, culturally responsive teaching focuses on using instructional approaches that center on the "cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them" (Gay, 2018, p. 36). See Appendix B for a literature review of the causal evidence of culturally responsive education on a range of student outcomes.

Building on the work of Ladson-Billing and Gay, developers and researchers have worked to integrate cultural responsiveness into technology education and educational technology, sometimes referred to as computing in the literature (Eglash et al., 2013; Morales-Chicas et al., 2019; Scott et al., 2015). The rationale for integrating culturally responsive education into technology and computing education is as follows: (a) the technology industry is lucrative, (b) women and people of color are underrepresented in technology and computing fields, (c) there is unequal access to and participation in technology education, and (d) technology is a crucial tool for social innovation and change (Charleston et al., 2014; Margolis et al., 2011; Morales-Chicas et al., 2019; Scott et al., 2015). A recent literature review identified prominent themes in the literature on culturally relevant education in computing, including sociopolitical consciousness raising, lived experiences, community connections, and personalization (Morales-Chicas et al., 2019). However, as the authors of that review point out, the field lacks large-scale quantitative evidence on the impact of culturally responsive education in technology education using credibly causal research designs. The evaluation of the CompuPower program works toward addressing this need.

Components of the CompuPower Program

In this section, we present the four key components of CompuPower: (a) the culturally responsive computing curriculum for the school-based CompuPower course, (b) professional development for the mentor teachers who teach the course, (c) the CompuPower Residency Experience, and (d) a program for parents. CompuPower is designed to be a collaboration among ASU CGEST, participating high schools and teachers, parents, and professionals working in STEM fields who serve as industry mentors to participating students. In the section "Was CompuPower Implemented as Intended," we describe the program as it was delivered, including how the COVID-19 pandemic and challenges emerging from implementing the program in rural communities interrupted some program components.

CompuPower Course Curriculum

Culturally responsive computing refers to a pedagogical practice that makes tacit connections among computational thinking; an individual's intersectional identities; and the three pillars of culturally responsive education: building on students' assets, providing opportunities for reflection, and providing opportunities among teachers and students (Eglash et al., 2013; Scott et al., 2015). The course curriculum applies theory to practice by emphasizing students' cultural backgrounds as assets on which instruction can build (Gay, 2014); developing and facilitating reflective small- and large-group activities that encourage students to analyze and oppose race, gender, and social class biases (Ladson-Billings, 2014; Paris, 2012); and co-constructing a supportive coalition of social actors that includes mentors, peers, and parents. Central to culturally responsive computing is its emphasis on society, science, and technology as drivers toward innovation (Wing, 2006, 2008). Although there is little research on culturally responsive computing, researchers and developers propose that it has the potential to engage students from groups that are typically underrepresented in STEM fields (Eglash et al., 2013; Scott, 2021; Wing, 2006).

The CompuPower curriculum is a high school course taught for a full academic year. The course curriculum includes 120 hours of instructional material divided across four quarters. In addition to its core focus on cultural relevance and responsiveness, the ASU CGEST website states that the curriculum is aligned to multiple learning standards, including the previous version of Arizona's educational technology standards, Arizona's career and technical education standards, and the Common Core State Standards focused on speaking and listening.

Each quarter of the course focuses on an aspect of power—power and identity, power and community, power and place, and power and social change—and is divided into five or six units. The units are divided into lessons that provide smaller activities or learning opportunities about the aspect of power that is the quarter's focus. The sidebars on the following pages describe sample lessons from each quarter. During the first quarter, students participate in lessons on power, identity, and technology, including discussions and activities focused on defining power, grappling with issues of identity, navigating technology, defining intersectionality, and building a website. The second quarter is focused on community, and students engage in lessons on the role of family and community, how to conduct interviews, and digital storytelling. The third quarter focuses on the role of place, coalition building, coalition management, problem solving about social issues, graphic design (e.g., developing an infographic), and coalition marketing (e.g., developing a public service announcement). During the third quarter, students also begin working on a capstone project that focuses on building a coalition. To develop the project, students work in small groups to select and conduct research on a social or community issue and use various technologies to describe, analyze, and offer solutions to the issue.

A central focus of the fourth and final quarter is students' continued work on their coalition projects, which they will present as part of the CompuPower Residency Experience. To support students as they develop the project, the fourth quarter curriculum also includes lessons on coding for social change (i.e., developing a webpage), community engagement, and opportunities to practice and get feedback on their coalition projects and presentations.

As students engage with the content of the CompuPower units, they are expected to accomplish a set of objectives that demonstrate their understanding of leadership and technology. Examples of unit objectives include "Students will be able to read, discuss, and reflect on the characteristics of STEM leaders" and "Students will be able to analyze power through technology and its impact on the community." See Appendix C for a full list of CompuPower's quarterly learning objectives. Contact ASU CGEST for a full description of the curriculum.

Focus Areas for the CompuPower Curriculum: Semester 1

Quarter 1: Power and Identity. Students describe their identity and learn about topics such as privilege and intersectionality. Example lessons include the following:

- Students create a drawing that represents themselves and aspects of their identifies (e.g. family, hobbies, values) and consider their future identities.
- Students research the portfolio websites of STEM leaders and create their own website that communicates their identities, skills, and project work.

Quarter 2: Power and Community. Students learn about the concept of community and how power influences the dynamics of a community. Example lessons include the following:

- Students explore their school website and discuss whether their community is portrayed accurately.
- Students learn about digital storytelling and its impact on a community through their own storyboarding and making a storytelling video.

Students demonstrate mastery of these objectives by completing projects and assignments, which CompuPower calls "student deliverables." Students complete their deliverables using a variety of tools and skills. Examples of the types of tools and applications that students use include photo, audio, and video capture software; editing software; and cloud-based document management applications. Skills that students develop and apply include project planning; communication and collaboration; and basic coding, such as HTML text editing and webpage coding. Students' work on the deliverables supports their ability to plan and create a capstone project that applies their new knowledge and skills to an area of social change.

Mentor Teacher Professional Development

Recognizing the potentially important role of teachers in supporting students as they consider postsecondary STEM education opportunities (Peterson et al., 2015), one of the key components of the program is to provide professional development for the mentor teachers. Each participating school selects a mentor teacher who teaches the school-based CompuPower course during the school year. The professional development introduces mentor teachers to the CompuPower curriculum and provides them with the knowledge and skills to use culturally responsive and gender-inclusive practices in their teaching.

The professional development includes a 2-day workshop in the summer, asynchronous online activities, and quarterly informal check-ins between an ASU CGEST staff member and each mentor teacher. A member of the ASU CGEST staff leads the 2-day summer workshop, which combines lecture and activities covering CompuPower's history, as well as methods for providing culturally relevant and responsive teaching in a course that centers on the use of technology. The mentor teachers also learn about the lessons and student deliverables that make up the CompuPower curriculum, described in the previous section. The focus of the asynchronous online training that follows the 2-day summer training is understanding bias and how to interact with students on these issues. The quarterly informal check-ins create a channel for mentor teachers to speak with ASU CGEST staff about their questions and experiences teaching the course.

Focus Areas for the CompuPower Curriculum: Semester 2

Quarter 3: Power and Place. Students learn about the concept of "place" and discuss how the influence of power and authority figures can shape a place. Example lessons include the following:

- Students identify an issue at their school, form a coalition to solve the problem, and develop a project management plan to address the issue.
- Students use graphic design to create infographics or public service announcement videos about their coalition project.

Quarter 4: Power and Social Change. Students continue work on their coalition projects and add new elements, such as a webpage or community engagement artifacts. Example lessons include the following:

- Students create a presentation about their coalition project that provides background information, their project plan, and their plan for community engagement.
- Students practice their presentation and then present their coalition projects during the CompuPower Residency Experience.

Parent Academy

CompuPower developers recognize that parents must be strategically included in educational intervention efforts for students from underrepresented groups (Scott et al., 2014). Both correlational and causal evidence suggest that parents have a role in students' academic success in secondary and postsecondary education. Multiple studies have demonstrated associations between parents' expectations and their children's academic success (see, e.g., Kirk et al., 2011; Rimkute et al., 2012; Wilder, 2014). In addition, an experimental study of a program designed to increase parents' understanding of the value of STEM education found that it increased how much parents value STEM fields, and, in turn, their children went on to take more STEM courses in high school (Rozek et al., 2015; Rozek et al., 2017).

As designed, the CompuPower program includes a 14-hour parent workshop series (seven 2-hour sessions) to help parents support their children as they pursue mathematics and science opportunities in high school and postsecondary education.[2] The CompuPower developers anticipated that this workshop series would be especially valuable given their expectation that many parents of CompuPower students would be unfamiliar with the U.S. secondary and postsecondary education system. The workshop series is led by a local community member, which may foster parents' interest and trust in the information provided (Dounay, 2008). Workshop sessions are adapted from an existing curriculum offered by the American Dream Academy, an affiliate of ASU. Additions to the American Dream Academy curriculum align with CompuPower's objectives and include activities to support parents in the following areas: setting academic goals for students that would prepare them for STEM majors; helping students develop academic success behaviors, including persisting in STEM study; becoming familiar with the financial aid process; discussing high school, postsecondary, and career options with their child; and helping students build a college portfolio. Workshop facilitators also work with parents to help them support their child's participation in the CompuPower Residency Experience.

CompuPower Residency Experience

Numerous studies conducted with students from groups underrepresented in STEM careers and first-generation college students suggest that experiential learning—for example, out-of-classroom activities, living-learning communities, precollege summer programs, and internships—benefit students' academic outcomes. For example, evidence from a mixed methods study suggests that experiential learning can promote middle school students' interest and motivation in mathematics and science (Weinberg et al., 2011). Other research suggests that participating in a living-learning program positively influences undergraduate women's interest in and motivation toward studying STEM in graduate school (Szelényi & Inkelas, 2011). Longer term studies have identified positive relationships between informal learning and self-efficacy and participation in science-related activities or courses, as well as interest in science-related careers (Markowitz, 2004; Redmond, 2000). Research also suggests that experiential STEM learning can promote students' preparedness, sense of belonging, and retention in their STEM discipline (Tomasko et al., 2016).

[2] Implementation challenges precluded inclusion of the Parent Academy as part of the program. In this section, we describe the Parent Academy's planned design.

The structure of the CompuPower Residency Experience draws on experiential learning research.[3] The CompuPower Residency Experience is a 3-day residential program hosted at ASU and offered in early May, before the end of the school year. It provides an on-campus residential learning experience for students that includes culturally responsive computing activities, exposes students to life on a college campus, and provides opportunities to interact with college students trained to serve as resident assistants. ASU CGEST's industry partners commit to providing one industry mentor for each participating school who delivers talks, leads field trips, and provides mentorship during the CompuPower Residency Experience. Each industry mentor participates in training to support their involvement during the CompuPower Residency Experience. The final day of the CompuPower Residency Experience centers on a program in which students present their capstone project to an audience of family, school personnel, and industry mentors.

Evaluation Design

With funding provided by the i3 development grant, ASU CGEST implemented the CompuPower program in 12 high schools in Arizona for 4 years—2 years for a pilot phase that allowed for continued program development and 2 years for the impact evaluation. During the 4 years, 537 students participated in some version of the program. This report focuses on the nine mostly rural schools that participated in the evaluation. ASU CGEST staff recruited the schools to participate in a quasi-experimental design study that would collect data from students who took the CompuPower course (the treatment group), as well as students who did not participate (the comparison group). Because the course was appropriate for high school students of any grade, each school determined the grade levels from which students could take the course. AIR and ASU CGEST worked with school staff to distribute information about the study to parents of students in the relevant grade levels and to collect parents' written permission for their child to participate in data collection activities.

AIR conducted an independent impact evaluation and an implementation evaluation for the project. The impact evaluation answers three research questions about the effect of CompuPower on the targeted student outcomes. The implementation evaluation describes the extent to which the program was implemented with fidelity to its design. This section describes the study design of the impact evaluation, the sample of participating schools and students, measures and data collection methods, and our analytic approach for the impact evaluation.

[3] Because of the COVID-19 pandemic, the CompuPower Residency Experience was not implemented as an in-person experience. In this section, we describe the CompuPower Residency Experience's planned design.

Impact Study Design

AIR conducted the impact evaluation using a student-level quasi-experimental study with a matched comparison design to generate causal estimates of CompuPower's impact on student social-emotional and academic achievement outcomes. Five Cohort 1 schools and their students participated during the 2019–20 school year, and six Cohort 2 schools and their students participated during the 2020–21 school year, including two that participated in the first year. AIR used propensity score matching to pair CompuPower students with similar students from the same grade, same cohort, and similar schools who did not participate in the program.

The impact evaluation investigated one confirmatory research question:

1. Did the CompuPower program have an effect on students' self-regulation?

This confirmatory research question addresses the outcome that ASU CGEST considered the essential social-emotional outcome for the CompuPower program of the two we examined. A positive impact on self-regulation would be considered evidence that confirms the intervention's overall effectiveness.[4]

In addition, we examined two exploratory questions, one addressing an additional social-emotional outcome and the other addressing an academic achievement outcome:

2. Did the CompuPower program have an effect on students' critical thinking skills for everyday life?
3. Did the CompuPower program have an effect on students' grade point average?

For all three research questions, we examined whether the CompuPower program affected the targeted outcome of high school students who participated in the program compared with high school students who did not participate in the program.

Sample

Nine schools participated in the evaluation. Building on their commitment to providing innovative education programs to students in rural communities, ASU CGEST staff focused their recruitment efforts on schools that met the rural definition outlined in the notice inviting applications (*Department of Education Notice of Applications for New Awards*, 2016). This definition specified that a school would be considered rural if it was part of a local education agency (LEA) that qualified for the Rural Education Assistance Program (REAP) at the time the

[4] We include a single confirmatory research question focusing on social-emotional outcomes, instead of having confirmatory research questions for both social-emotional outcomes, to reduce the likelihood of finding a statistically significant effect by chance. ASU CGEST designated self-regulation as the confirmatory research question before AIR collected any outcome data.

school joined the study.[5] Of the nine schools that participated in Cohort 1 and Cohort 2 (in the 2019–20 and 2020-21 school years, respectively), all but one was from a LEA that met the i3 program's definition of rural.[6] However, although most schools were in REAP-eligible LEAs, not all schools were in rural locales. According to the locale classifications from the National Center for Education Statistics (NCES),[7] three schools were rural (33%), two were in a town (22%), two were in a suburb (22%), and two were in a small city (22%). Exhibit D1 in Appendix D lists the schools that participated in each cohort, their locale classification, and whether the school's LEA met the rural criteria established in the notice inviting applications.

Exhibit 1 presents the characteristics of the schools that participated in the evaluation. The schools varied on most of the characteristics for which we have data, including school type (i.e., regular public school or charter school), school size, the percentage of students eligible for free or reduced-price lunch, the distribution of students by race/ethnic group, and the 4-year graduation rate. However, almost all schools were eligible for Title I funds.

All participating schools offered CompuPower as an elective course, but the schools varied in terms of which grade levels of students could enroll. Some schools allowed students from a single grade to take the course, whereas others allowed students from multiple grades. Once schools agreed to participate in the study, the AIR research team and ASU CGEST staff worked with school staff to obtain written parental consent for all students in each grade level that was eligible to enroll in the CompuPower course at that school.

[5] An LEA was part of the REAP if it was eligible for the Small Rural School Achievement program or the Rural and Low-Income School program authorized under Title VI, Part B, of the Elementary and Secondary Education Act. AIR obtained the annually updated REAP Master Eligibility Spreadsheet of eligible LEAs from the U.S. Department of Education's website. Overall, CompuPower met the criteria for serving rural communities in that more than half of the students served by the program attended schools located in a REAP-eligible LEA.

[6] The exception is a school that shares a name with another school in a different LEA, one that was not part of the REAP program. AIR and ASU CGEST determined the school was not in a REAP-eligible LEA until after the school signed the memorandum of understanding to be part of the project.

[7] Locale classifications are geographic indicators that describe the type of area where a school is located. NCES classifies all territory in the United States as either rural, town, suburban, or city, and each type is divided into three subtypes depending on the locale's population size or its proximity to a populated area. For more information on locale classifications, see https://nces.ed.gov/programs/edge/Geographic/LocaleBoundaries.

Exhibit 1. School-Level Characteristics for Participating Schools

School	Charter school	Title I eligible	Students (*N*)	Female (%)	FRPL (%)	Hispanic (%)	White (%)	Black (%)	Asian (%)	4-year graduation rate	Dropout rate (%)
Cohort 1 (2019–20)											
Apache Trail High School	Yes	Yes	185	45%	56%	36%	58%	2%	0%	36%	16%
Miami High School	No	Yes	440	49%	45%	53%	41%	1%	1%	85%	3%
Pima High School	No	Yes	274	46%	28%	20%	74%	1%	0%	90%	3%
Sequoia Pathways High School	Yes	Yes	1,146	51%	na	28%	55%	9%	2%	93%	2%
Show Low High School	No	Yes	767	47%	35%	16%	79%	1%	1%	84%	4%
Cohort 2 (2020–21)											
Berean Academy	Yes	Yes	388	48%	47%	32%	49%	9%	0%	73%	2%
Learning Foundation and Performing Arts	Yes	Yes	444	59%	30%	31%	50%	9%	1%	80%	2%
Mayer High School	No	Yes	156	43%	72%	24%	65%	1%	1%	72%	3%
Miami High School	No	Yes	509	48%	42%	53%	38%	1%	1%	94%	4%
Northland Prep	Yes	No	644	52%	0%	13%	75%	0%	2%	97%	2%
Show Low High School	No	Yes	784	49%	27%	14%	80%	0%	1%	81%	5%
School sample[a]	—	—	522	50%	26%	27%	62%	4%	1%	85%	3%

Note. Students = the total number of students in the school, which for most schools includes grades that did not participate in the CompuPower study; *N* = number; FRPL = eligibility for the free or reduced-price lunch program; na = not available because the information is masked by the National Center for Education Statistics. Data are sourced from the Common Core of Data (2019-20).

[a] The means for the full school sample are weighted by the number of students in each school, except for the number of students, which an unweighted mean.

Within each school, students who enrolled in the course at the beginning of the school year were in the CompuPower group (the treatment group) and all non-CompuPower students from the same grade level(s) were eligible for the comparison group. Exhibit 2 summarizes the number of students from each school in the targeted grades (i.e., the grade levels that could enroll in CompuPower) in the CompuPower and comparison groups, as well as the percentage of students whose parent or guardian returned a signed parental consent form. As the table indicates, the percentage of eligible students with permission to participate in data collection activities was low, with 66% of CompuPower students and 43% of non-CompuPower students receiving parental consent.

Exhibit 2. Numbers of Students by Study Condition

Cohort	School	CompuPower students		Non-CompuPower students	
		N students in targeted grade(s)	Percentage of students with consent (*N*)	*N* students in targeted grade(s)	Percentage of students with consent (*N*)
Cohort 1, 2019–20 school year	Apache Trail High School	18	50% (9)	168	50% (84)
	Miami High School	13	92% (12)	74	69% (51)
	Pima High School	19	63% (12)	274	43% (119)
	Sequoia Pathways High School	17	76% (13)	239	62% (147)
	Show Low High School	8	50% (4)	547	39% (215)
Cohort 2, 2020–21 school year	Berean Academy	43	47% (20)	31	39% (12)
	Learning Foundation and Performing Arts	11	100% (11)	216	61% (131)
	Mayer High School	11	91% (10)	78	40% (31)
	Miami High School	21	62% (13)	57	53% (30)
	Northland Prep	11	91% (10)	65	68% (44)
	Show Low High School	7	71% (5)	416	17% (70)
Cohorts 1 and 2	All schools	179	66% (119)	2,165	43% (934)

Note. Data are based on authors' analysis of student rosters for the targeted grades in each school and program data collected by ASU CGEST.

With the low parental consent rates, we wanted to examine the characteristics of students who we ultimately included in our analyses with the overall characteristics of students in the participating schools. Exhibit 3 presents the characteristics of students in the participating schools with parental consent. The exhibit has three sections. The first section includes all students with parental consent, including those with incomplete survey data or who were not in the social-emotional outcomes analytic sample or the GPA analytic sample.[8] The middle section includes students who were in the analysis of the social-emotional outcomes. The right section includes students in the GPA analysis.

There are at least two potentially relevant differences between the characteristics of all students in the participating schools (Exhibit 1) and the characteristics of students in the analytic samples (Exhibit 3). For example, the percentage of White students across all schools is 62%, whereas the percentage of White CompuPower students is 73% and 69% in the survey and GPA analytic samples, respectively. The percentage of students eligible for free or reduced-price lunch across all schools is 26%, whereas the percentage for CompuPower students is 44% and 39% for the survey and GPA analytic samples, respectively.

[8] As described in the "Analytic Approach for the Impact Study," there are two analytic samples of students: one for the social-emotional survey outcomes and one for GPA because the number of students with complete survey data and complete GPA differed.

Exhibit 3. Characteristics of Students in the Study, for All Students and Students in the Social-Emotional Outcomes and GPA Analysis Samples

Characteristics	All students with parental consent				All students in the social-emotional outcomes analytic sample				All students in the GPA analytic sample			
	CompuPower (*N* = 119)		Comparison (*N* = 934)		CompuPower (*N* = 62)		Comparison (*N* = 161)		CompuPower (*N* = 61)		Comparison (*N* = 152)	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Female (%)	49	50	59	49	50	50	51	50	51	50	48	50
Eligible for free or reduced-price lunch (%)	42	50	48	50	44	50	51	50	39	49	43	50
Hispanic (%)	28	45	24	43	23	42	16	37	21	41	16	36
White (%)	62	49	67	47	73	45	79	41	69	47	77	43
Black (%)	6	24	4	20	5	22	2	14	8	28	1	11
Asian (%)	2	16	2	13	0	0	2	14	2	13	3	18
American Indian or Alaska Native (%)	1	11	1	12	0	0	2	14	0	0	2	14
Two or more races (%)	0	0	2	13	0	0	2	16	0	0	1	08
Students with English learner status (%)	4	19	1	11	2	13	2	16	3	18	3	16
Prior year GPA	3.04	0.39	3.04	0.37	3.15	0.75	3.17	0.69	3.06	0.79	2.94	0.77

Note. GPA = grade point average; *N* = number of students; *SD* = standard deviation. Data are based on authors' analysis of school-provided administrative data.

Measures and Data Collection

This section describes the data sources and measures used to assess the impact and implementation of the CompuPower program. To assess CompuPower's impact on students, the AIR research team collected pre- and posttest survey responses from students with parental consent, as well as collected data from their administrative records. To measure implementation fidelity, ASU CGEST and AIR collected data, including mentor teacher attendance at professional development sessions, mentor teacher responses to a periodic survey asking them which CompuPower lessons they taught, and student participation in CompuPower Residency Experience activities. Exhibit 4 provides a detailed timeline of the data collection activities for each cohort.

Exhibit 4. Timeline of Data Collection Activities

	2019			2020				2021		
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Cohort 1 schools										
Pretest Student Survey[a]	X									
Baseline Administrative Data Request		X								
Teacher Implementation Survey		X	X	X	X					
Posttest Student Survey[b]					X					
Outcome Administrative Data Request						X				
Cohort 2 schools										
Pretest Student Survey[c]						X				
Baseline Administrative Data Request						X				
Teacher Implementation Survey						X	X	X	X	
Posttest Student Survey[b]									X	
Outcome Administrative Data Request										X

[a] One Cohort 1 school implemented CompuPower in spring 2020, as part of its block scheduling program. AIR administered the pretest survey in this school in December 2019. [b] For Cohorts 1 and 2, AIR administered the posttest student survey to CompuPower and comparison group students after CompuPower students participated in the CompuPower Residency Experience in early May. [c] Although AIR could administer the pretest student survey before the 2019–20 school year began, school closures in spring 2020 because of the COVID-19 pandemic delayed AIR's administration of the pretest student survey to fall of the 2020–21 school year.

Student Survey Measures of Social-Emotional Outcomes

To establish baseline equivalence and assess CompuPower's impact on noncognitive outcomes, AIR administered a pre- and posttest survey to all students with parental consent in both cohorts. Students completed the pretest survey before their school began implementing the

CompuPower program. For Cohort 1, students completed the pretest survey in the spring prior to their school's year of CompuPower implementation (i.e., spring 2018). With the COVID-19 challenges in spring 2020, Cohort 2 students completed the pretest survey immediately before their school began implementing the CompuPower program (i.e., September 2020). For Cohorts 1 and 2, students completed the posttest survey at the end of the school year when CompuPower students had completed all components of the CompuPower program, including the CompuPower Residency Program.

For the Cohort 1 pretest survey, an AIR researcher visited each school to administer the survey to students using the schools' preferred administration method (paper surveys or online surveys completed on school computers). The response rate for this survey administration was 88%. Because of the COVID-19 pandemic, all other survey administrations for the study were conducted virtually. After the onset of the pandemic, we worked with school staff to distribute an online survey link to students, as well as send reminders to complete the survey.[9] Recognizing that many students would not have access to a computer or high-speed internet access at home, AIR used an online survey platform configured for use with mobile devices as well as computers.

The overall response rate for students who completed both the pre- and posttest surveys for Cohorts 1 and 2 was 34%, representing 58% of the CompuPower students and 31% of the comparison group students.[10] The overall response rate was much lower than the response rate for the wave of data collection that we could support in person. This difference reflects the challenges of obtaining a high response rate during the COVID-19 pandemic when researchers could not visit schools to collect data in person and many students were attending school remotely.

The student survey included 48 questions drawn from three established measures of social-emotional outcomes. A brief description of each survey measure is in this section, and the complete survey instrument is in Appendix E. Appendix F describes the psychometric analyses we conducted to arrive at the final scales used in the analyses. For each survey scale, the research team used Rasch modeling for partial credit scoring to create scale scores based on students' survey responses scoring (Masters, 1982). Our analyses include only those students who completed both the pre- and posttest surveys.

Self-Regulation. We used the Adolescent Self-Regulatory Inventory (Moilanen, 2007) as the confirmatory social-emotional learning outcome for the evaluation. The original version of the Adolescent Self-Regulatory Inventory includes 14 items designed to measure students' long-

[9] To compensate school staff for their efforts to support data collection, AIR gave them a $250 gift card for each survey administration.
[10] For Cohort 1, 46% of the treatment students and 31% of the comparison group students completed both surveys, for an overall response rate of 32%. In Cohort 2, 68% of the treatment students and 32% of the comparison group students completed both the pre- and posttest surveys, for a total response rate of 37%.

term self-regulation (α = .82). Our psychometric analyses indicated the scale had lower internal reliability in our sample, and the factor loadings for several items approached zero. As a result, we created scale scores using nine of the original 14 items (α = .79). Examples of the items include "I can find a way to stick with my plans and goals, even when it's tough" and "I work carefully when I know something will be tricky." Respondents use a 5-point Likert scale to rate how true each statement is for them, with response options ranging from 1 (*not at all true for me*) to 5 (*really true for me*).

Critical Thinking Skills for Everyday Life. We used the Critical Thinking Skills for Everyday Life Scale (Mincemoyer & Perkins, 2005) as an exploratory social-emotional learning outcome for the evaluation. This original version of the scale includes 20 items (α = .85) and is designed to measure the extent to which students examine information, explore ideas, and demonstrate independent thought as part of their daily life. Our psychometric analyses indicated that two items had low factor loadings, so we created scale scores using 18 of the original 20 items (α = .89). Example items include "I think of possible outcomes before I take action;" "I plan how to get information on a topic;" and "I listen to the ideas of others even if I disagree with them." Respondents used a 5-point Likert scale to indicate how often they had done what is described in the statement in the last 30 days, with response options ranging from 1 (*never*) to 5 (*always*). Because we did not include the Critical Thinking Skills for Everyday Life scale on the Cohort 1 pretest survey, we used a different social-emotional outcome—academic possible selves—to establish baseline equivalence between CompuPower and comparison students for this outcome.

Academic Possible Selves. We used 14 items from the Persistent Academic Possible Selves Scale for Adolescents (Lee et al., 2016; α = .96)[11] as the baseline measure for critical thinking skills for everyday life.[12] Example items include "I am confident that I can improve my classroom grades next year;" "I can see myself being a better student next year;" and "Throughout next year, I will assess how much I pay attention in class." Respondents used a 7-point Likert scale to indicate the extent to which they agree with each statement, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

We originally planned to examine academic possible selves as an exploratory social-emotional outcome for the study. However, the Cohort 1 pretest data for the measure showed that students' endorsement of the items was high on average. A closer review of the items' wording combined with the lack of variability and students' high pretest scores led us to conclude that

[11] The full scale includes 51 items. After administering the full scale as part of the first survey administration, we selected a subset of items for future administrations to reduce the time burden associated with completing the survey.
[12] Academic possible selves is an appropriate baseline measure for critical thinking skills because (a) both scales measure noncognitive or social-emotional outcomes and (b) the Pearson correlation between the two measures is 0.60, which meets the threshold set by the What Works Clearinghouse for using different pre- and posttest measures from the same outcome domain.

academic possible selves would not provide useful information about CompuPower's effectiveness. In collaboration with ASU CGEST, we identified the Critical Thinking Skills for Everyday Life Scale as the replacement exploratory social-emotional outcome.

Student Administrative Data

This section describes the administrative data we collected from participating schools for students with parental consent. We used the administrative data for the propensity score matching, as covariates for the impact analyses, and as the pre- and posttest measures of academic achievement.

Demographic Characteristics and Prior Academic Achievement. To establish baseline equivalence between CompuPower and comparison students, we requested data related to students' demographic characteristics and prior levels of academic achievement. During the fall of the year the school implemented CompuPower, we requested the following demographic variables: gender, race/ethnicity, English learner status, free or reduced-price lunch eligibility, and grade level during the implementation year.[13] We also requested students' unweighted GPA for the year before students participated in the study.

Grade Point Average. To measure the impact of the CompuPower program on students' academic achievement, we requested students' unweighted GPA for the year the student participated in the evaluation (e.g., the year the student's school implemented CompuPower).

School Administrative Data

We used publicly available data from NCES for the 2019–20 and 2020–21 school years to examine school-level characteristics. The variables we used included charter school status, the percentage of female students, the percentage of students identified as receiving free or reduced-price lunch, the percentage of Hispanic students, the percentage of White students, the percentage of Black students, the percentage of Asian students, and the total number of students enrolled in the school. We also used publicly available data from the Arizona School Report Cards for the 2019–20 and 2020–21 school years to obtain 4-year graduation rates and dropout rates for schools.

CompuPower Program Implementation Data

To assess fidelity of implementation, we gathered information about the delivery of each CompuPower program component. The AIR research team either conducted primary data

[13] One high school declined to provide data on free or reduced-price lunch status and English learner status for all its students. To address this, we applied the dummy variable adjustment method for handling missingness to avoid excluding all students from this school from the analysis. Previous research demonstrates that the dummy variable adjustment method is more suitable than imputation methods for missing data when missingness applies to an entire site (Puma et al., 2009).

collection or requested extant program implementation data from the ASU CGEST team. This section briefly describes each of the program implementation data sources.

Mentor Teacher Professional Development Attendance Records. ASU CGEST expected mentor teachers to participate in an introductory training about the program and to complete additional trainings throughout the school year. We measured fidelity of the mentor teacher professional development implementation by analyzing professional development participation records that ASU CGEST collected throughout both years of the project.

Teacher Implementation Survey. To measure the extent of CompuPower course implementation, AIR administered an online survey to mentor teachers who taught CompuPower at the end of each academic quarter. The survey included a list of CompuPower lessons and student deliverables (i.e., assignments) for each unit and asked mentor teachers to select the lessons and deliverables they implemented in their classes. Because we knew that the mode of instruction would vary through the 2020–21 school year because of the COVID-19 pandemic, we also asked Cohort 2 mentor teachers to describe the mode of instruction they had used with CompuPower students in the preceding quarter (e.g., in-person, virtual, hybrid). An AIR researcher emailed the online survey link to teachers at the end of each quarter and followed up as needed to remind teachers to complete it. The response rate for all 11 mentor teachers on the survey was 100%. See Appendix E for sample items from the teacher survey.

CompuPower Residency Experience Records. Key indicators of adequate CompuPower Residency Experience program delivery included participation from students and industry mentors. The expectation was for industry mentors to attend all days of the CompuPower Residency Experience. The expectation for students enrolled in the CompuPower program was to attend the full CompuPower Residency Experience, as well as complete the collaboration project during the second semester and present it. To capture fidelity of the Residency Experience implementation, we collected industry mentor and student attendance records and tracking sheets related to student group project presentations from ASU CGEST.

Analytic Approach for the Impact Study

This section describes our analytic approach to creating equivalent CompuPower and comparison groups using propensity score matching for the impact analyses, the baseline characteristics of the analytic samples of students in the CompuPower and comparison groups, and our approach to conducting the impact analysis.

Propensity Score Matching

To address the nonrandomization of assignment—in other words, that students decided on their own whether to take the CompuPower class—and to control for the baseline differences in the two groups, the research team used propensity score matching to create CompuPower and comparison groups that shared similar baseline characteristics. We began by defining the eligible sample for the propensity score matching as any student with nonmissing values on all baseline measures.[14] Using this sample, we then conducted nonreplacement full matching (Hansen, 2004) to pair each student in the CompuPower group with up to five comparison students who had the same or similar estimated propensity scores within the same grades and cohorts (see Appendix G for the propensity score estimation model). The propensity score analysis provides a set of diagnostics to gauge the similarity of the CompuPower and comparison groups prior to estimating the program's effects. Reducing differences between the CompuPower and comparison groups helps mitigate the possibility that baseline group differences are responsible for any outcome differences (Austin, 2011).

The What Works Clearinghouse (WWC) standards require baseline equivalence on our pretest measures of the outcome variables. Recognizing that there may be other important differences in students who choose to enroll in CompuPower and those who do not, and these differences could bias the estimates of the program's impact, we included a range of student-level background characteristics and school-level characteristics in the propensity score model, as well as the pretest measures of outcome variables.[15] We also required that each CompuPower student be matched to comparison students from the same cohort and the same grade level.

Because the number of students with complete survey data and complete GPA data differed, we conducted propensity score matching twice: once for the social-emotional learning outcomes and once for GPA. Both analyses produced matches for all CompuPower students. Exhibits H1 and H2 in Appendix H present tables that include all student-level and school-level measures used for each outcome, as well as information on the sample sizes before and after matching.

Baseline Equivalence of the CompuPower and Comparison Groups

After conducting the propensity score matching, we examined the analytic samples to determine that the CompuPower and comparison groups in the study sample had baseline equivalence. As presented in Appendix H, the CompuPower and comparison groups met the criteria for equivalence on student-level characteristics, as well as for most school-level measures for both analytic samples. For the analytic sample used for the social-emotional outcome analysis, the two school-level covariates that violated baseline equivalence were the

[14] The exception to this requirement was the students from one school who were missing data for free or reduced-price lunch status and English learner status, for whom we applied the dummy variable adjustment method for handling missingness.
[15] The percentage of Asian students; the percentage of American Indian students; the percentage of students of two or more races; the percentage of English learners at the school level; and variables indicating whether a student was Black, American Indian, or of two or more races were not included in the propensity score matching because of the extremely small proportion of students were Asian (< 3%), English Learners (< 2%), American Indian (1%) and no treatment students were Black or of two or more races.

school-level averages for the pretest self-regulation and academic possible selves scale scores. For the sample used in the GPA outcome analysis, the two school-level covariates that violated baseline equivalence were the percentage of Black students in the school and the school-level average of the pretest academic possible selves scale score. The comparison group had slightly lower scores on these school-level characteristics than the CompuPower group in both analytic samples. Exhibits H1 and H2 in Appendix H provide the details on baseline equivalence for all measures.

Impact Analysis Method

We estimated the impact of the CompuPower program by using a two-level random effects model separately for each student outcome. The analyses compared each outcome for students in the CompuPower group to students in the comparison group. Each model controlled for all student-level and school-level baseline characteristics to account for any residual baseline group differences after matching. See Appendix G for more information on the statistical models we used to estimate the impact of the CompuPower program.

Was CompuPower Implemented as Intended?

Before turning to the results of the impact analyses, this section describes the implementation fidelity of the CompuPower program for both cohorts. At the outset of the project, ASU CGEST staff defined what an "adequate" level of implementation would entail for all four key components of the intervention. Appendix I provides detailed information on how ASU CGEST defined adequate implementation for each component and subcomponent of the program and how we calculated implementation fidelity scores.

CompuPower was implemented with two groups of schools: Cohort 1 schools participated during the 2019–20 school year, and Cohort 2 schools participated during the 2020–21 school year. The onset of the COVID-19 pandemic in March 2020 interrupted the planned implementation in both cohorts, albeit in different ways. For both cohorts, implementation of the mentor teacher professional development met the criteria for adequate implementation fidelity, but the other three components were interrupted, modified, or not offered.

This section describes how each component of the CompuPower program was implemented during the 2-year project, including the implementation challenges. Although most implementation challenges resulted from the COVID-19 pandemic, there were other challenges as well. We also report the implementation scores for each cohort and whether the component met the criteria for implementation fidelity by cohort and across both years of the project. Exhibit 5 presents both the intended and actual timeline for when each program component was implemented with each cohort. The highlighted cells indicate the intended timing, and the dots indicate the actual timing. Exhibit 6, at the end of this section, presents a summary of the implementation fidelity for all four components of the CompuPower program by cohort and across both cohorts.

Exhibit 5. Timeline of CompuPower Program Implementation

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Cohort 1 schools (2019–20 school year)											
Mentor Teacher Professional Development[a,b]	●										
CompuPower Course Curriculum[b]		●	●	●	●	●	●	●	●	●	●
Parent Academy[c]											
CompuPower Residency Experience											●
Cohort 2 schools (2020–21 school year)											
Mentor Teacher Professional Development[a]	●		●		●		●		●		
CompuPower Course Curriculum[d]				●	●	●	●	●	●	●	●
Parent Academy[c]											
CompuPower Residency Experience											●

[a] This exhibit presents when ASU CGEST offered the mentor teacher professional workshop content but excludes the online asynchronous activities or the informal check-ins. For Cohort 1, all substantive professional development content was delivered in the 2-day summer workshop, as originally planned. For Cohort 2, the content was delivered in the summer workshop plus four 3-hour workshops held throughout the school year. Teachers completed the asynchronous online content at the beginning of the school year, and informal check-ins between mentor teachers and ASU CGEST staff occurred throughout the year. [b] One participating school offered CompuPower as a semester-long course using a block schedule (classes met for 100 minutes on average each day for 4.5 months, instead of 45 minutes on average for 9 months). As a result, all teacher professional development and course activities took place January through May 2020. [c] The Parent Academy was not offered to parents and guardians of Cohort 1 or Cohort 2 students. [d] The start of the CompuPower course curriculum was delayed in Cohort 2 classes for 6 weeks to allow time to obtain parental consent for students participating in the evaluation and to administer the beginning-of-year student survey, both of which needed to occur before students began the CompuPower course.

CompuPower Course Curriculum

As described previously, the yearlong CompuPower course curriculum consisted of lessons and student deliverables that mentor teachers presented to high school students. This section describes the implementation of the course in the participating schools.

For the curriculum to be implemented with fidelity, more than 75% of the teachers had to meet the criteria for adequate implementation of the course, which ASU CGEST defined as teaching more than 80% of the course lessons and assigning more than 75% of the student deliverables. In Cohort 1, two of the five classes (40%) met both criteria, and in Cohort 2 four of the six classes (67%) met both criteria. Across the two cohorts, only 55% of the classes met the criteria for adequate implementation fidelity, indicating that this component of the program was not implemented with fidelity. As described in the remainder of this section, the low implementation fidelity could be related to challenges presented by the COVID-19 pandemic.

Cohort 1

From August 2019 through March 2020, mentor teachers taught the CompuPower course curriculum in their classes as originally designed by ASU CGEST. However, at the start of the COVID-19 pandemic in March 2020, all participating schools transitioned to remote learning for the remainder of the school year, so teachers could not implement the curriculum as planned. The extent to which mentor teachers were able to teach CompuPower from March through the end of the school year varied across schools, with one school continuing to teach all remaining lessons virtually, two schools attempting to teach some of the remaining lessons, and two schools ending the course in March. Challenges to completing the course after March 2020 included schools recognizing that most of their students did not have the technology necessary to participate in virtual instruction (laptops or internet access), schools assigning CompuPower mentor teachers to different courses, and schools forgoing elective courses to instead devote resources to providing core subject academic content and meals to students.

ASU CGEST also recognized that students would not be able to carry out the course’s capstone project during the curriculum’s fourth quarter. As designed, students would have collaborated in small groups to identify a social problem and conduct research to identify a possible solution. Because remote instruction interrupted students’ ability to work with each other and receive support from the mentor teacher, ASU reconfigured the fourth quarter curriculum. The revised curriculum provided students with resources to develop a project that focused on developing plans to create a coalition that focused on infectious diseases—a topic that held significant meaning in spring 2020. ASU CGEST’s goal was to provide students with the support and scaffolding necessary to complete a capstone project during a time when students were more disconnected from their school and encountering increased stressors in their lives.

Cohort 2

CompuPower classes had access to the full course curriculum during the 2020–21 school year and met without the weeks-long closures experienced in spring 2020. However, there were two important modifications to how teachers offered CompuPower to Cohort 2 students, all related to the COVID-19 pandemic. First, teachers did not begin teaching the CompuPower curriculum until 6 weeks into the school year. This delay was to ensure that students in the CompuPower classes did not begin the course activities before taking the beginning-of-year student survey.[16] During this period, teachers provided digital etiquette lessons for 2 weeks, and ASU then enrolled students in self-paced online classes covering topics that included using Photoshop, graphic design, creating websites, and making and editing videos using a smart phone. Although some of the content overlapped with skills-based content in the CompuPower course, these online courses did not incorporate the culturally responsive educational practices that are central to CompuPower. Once students completed the beginning-of-year survey, ASU CGEST provided the CompuPower curriculum to mentor teachers and confirmed that teachers could begin teaching the content to their classes.

A second important modification to the course was that the instructional format for CompuPower classes varied throughout the school year. How classes met changed throughout the year and ranged from fully in-person to hybrid (with some students attending in person and others participating remotely) to fully remote, with some schools transitioning multiple times within a quarter.[17] Anticipating that some schools might continue to provide remote instruction to students during the 2020–21 school year, ASU CGEST worked with an instructional designer in summer 2020 to create an online version the CompuPower curriculum that mentor teachers could use for hybrid or remote instruction. The course content and student deliverables remained the same in the online version, with the primary difference being that course materials and activities could be accessed electronically through a digital platform. Throughout the school year, teachers could use either the original paper-based curriculum or the online version of the curriculum.

The CompuPower classes' delayed start in using the CompuPower curriculum (to accommodate data collection activities that could not take place in spring 2020) and the interruptions to in-person learning during the school year could be at least partially responsible for Cohort 2's low implementation fidelity. However, we should not rule out that teachers might have decided not to teach the full course for other reasons.

[16] The i3 program, which funded the project, required that AIR conduct an evaluation of the impact of CompuPower on student outcomes that meets WWC standards. These standards require that students in the treatment group participate in pretest data collection activities before they begin participating in the program being studied. This allows the evaluator to use the pretest data to determine whether there is baseline (or initial) equivalence between the treatment and comparison groups before students begin participating in the program. The project team could not carry out its original plans to obtain parental consent and administer the survey in spring 2020 because students were participating in remote instruction because of the COVID-19 pandemic. Details about the study design are provided in the Evaluation Design section.

[17] As part of the Cohort 2 quarterly teacher survey to measure implementation of the CompuPower course, we asked teachers to describe their instructional format for each quarter of the 2020–21 school year.

Mentor Teacher Professional Development

This section describes mentor teachers' participation in the professional development, as well as how ASU CGEST modified the professional development structure after the first year to address issues raised by Cohort 1 teachers.

For this component to be implemented with fidelity, at least 75% of the teachers in both cohorts had to attend the summer professional development, complete the online asynchronous activities, and participate in at least half of the quarterly meetings. Mentor teachers' participation in the teacher professional development met the criteria for adequate implementation fidelity. In Cohort 1, 80% of the mentor teachers participated at this level; in Cohort 2, 100% did so. Across both cohorts, 91% of teachers met the criteria for adequate implementation.

Cohort 1

ASU CGEST offered mentor teachers of the CompuPower course professional development activities as they were originally designed during the 2019–20 school year. During summer 2019, teachers who agreed to teach the CompuPower course participated in ASU CGEST's 2-day in-person professional development workshop. As described previously, the topics covered in the professional development included an introduction to culturally responsive pedagogy and culturally responsive computing, and an overview of the CompuPower course curriculum. During the 2019–20 school year, ASU CGEST offered the asynchronous online activities to mentor teachers and held four informal check-ins with teachers throughout the year to discuss questions and offer support as needed.

Cohort 2

Although Cohort 1 teachers received all planned professional development content in the summer prior to their CompuPower implementation, for Cohort 2 the content was spread across multiple professional development sessions. ASU CGEST made this change after conducting formative interviews with Cohort 1 mentor teachers in spring 2020. During the interviews, teachers shared that they could no longer recall the information shared during the summer workshop by the time they arrived at the course content for each quarter during the school year. Based on this information, ASU CGEST revised the structure and content of the professional development for the 2020–21 school year in two ways. First, they revised the summer workshop to include more content to support teachers' understanding of culturally responsive education practices, as well as provide an overview of the 6-week curriculum they delivered at the beginning of the school year that did not include CompuPower content. Second, in place of quarterly informal one-on-one check-ins between teachers and ASU CGEST staff, teachers participated in formal 3-hour professional development sessions each quarter. During each session, mentor teachers engaged in professional development activities that covered each quarter's curriculum, learning objectives, and student deliverables. This new structure allowed teachers to learn and ask questions about the upcoming course content a few weeks before they began teaching it, rather than months earlier. As such, the professional development was relevant and at the forefront of teachers' minds when they begin covering the content with their students.

Parent Academy

The Parent Academy was to be a workshop series for parents offered at each participating school for parents and guardians of students in the CompuPower course. Offering the Parent Academy required each participating school to identify a local volunteer who would devote time to complete the training required for leading the workshop series, in addition to preparing for and leading the seven 2-hour Parent Academy workshop sessions. The training required volunteers to travel to the ASU campus in Tempe to participate in a full-day orientation and eight 2-hour training sessions provided by American Dream Academy staff. With participating schools located up to 3 hours from ASU, none of the schools identified a volunteer to participate in the training. Although ASU CGEST and the American Dream Academy considered options for providing virtual training for the Parent Academy leaders, this did not materialize.

Although finding a volunteer able to participate in the training was a significant obstacle to implementing the Parent Academy, the mismatch between the Parent Academy content and the experiences of many parents of CompuPower students was another. ASU CGEST piloted the Parent Academy with a group of parents whose children took CompuPower during the pilot phase of the program. The Parent Academy content was targeted to parents who were unfamiliar with the U.S. postsecondary education system and whose children would be the first generation in their family to go to college. However, parents of CompuPower students who attended the pilot program reported that many had attended college in the United States, so the content was not relevant for them.

For this program component to be implemented with fidelity, parents or guardians of at least 75% of CompuPower students had to have attended at least six of the seven planned workshop sessions. The Parent Academy did not meet the criteria for adequate implementation fidelity because the workshop series was not offered for either cohort.

CompuPower Residency Experience

Challenges presented by the COVID-19 pandemic during both years of the project had major implications for the CompuPower Residency Experience component of the program. As originally designed, the program would have brought students to the ASU campus for several days and recruited industry mentors to be actively involved in the planned activities. As described in more detail later in this section, although ASU CGEST devoted considerable efforts to creating alternate virtual experiences for students in both cohorts, they were not able to recruit industry mentors to participate in either year. Furthermore, there were understandable obstacles to students participating in the virtual activities given the surrounding circumstances, especially for Cohort 1 in spring 2020.

For the CompuPower Residency Experience to be implemented with fidelity, at least 80% of the students had to submit a student project and attend the full CompuPower Residency Experience, and at least eight industry mentors had to attend all days of the program across both cohorts.[18] Despite ASU CGEST's efforts to provide Cohort 1 students with a meaningful end-of-year virtual experience on very short notice, no students had the opportunity to participate in a program that had the same level of intensity as the planned CompuPower Residency Experience, and no industry mentors participated. In Cohort 2, 19% of the students participated in a multiday virtual CompuPower Residency experience—and 84% attended at least 1 day—but no industry mentors participated. As a result, this component of the program did not meet the criteria for adequate implementation fidelity.

Cohort 1

The onset of the COVID-19 pandemic led ASU CGEST to dramatically alter the CompuPower Residency Experience so that students could participate in a set of end-of-year activities, albeit in a reduced and virtual setting. To address that all schools were engaged in remote instruction, in a few short weeks, the ASU CGEST team developed a slideshow presentation that teachers could share with their students. Depending on each school's instructional format at the beginning of the COVID-19 pandemic, teachers and students could view the presentation together (e.g., during synchronous online instruction) or students could watch it on their own. The 54-slide presentation covered the types of topics ASU CGEST had planned to include in the in-person CompuPower Residency Experience, including college life, STEM careers, and students' CompuPower projects. Although students could not participate in an on-campus experience, the PowerPoint included video testimonials from college students and slides about college majors, student life, and financial aid. At the end of the PowerPoint, students could click on a link to view their peers' CompuPower projects about infectious diseases. ASU CGEST shared the slideshow presentation with teachers in May 2020, approximately when students would have participated in the in-person residency experience. The original in-person CompuPower Residency Experience would have lasted 3 days, but the presentation was designed to be viewed across two 1-hour sessions. Despite the immense challenges that teachers and students encountered at the onset of the COVID-19 pandemic in spring 2020, students from three of the five schools participated in the virtual CompuPower Residency

[18] ASU CGEST planned to recruit one industry mentor in each cohort for each participating school. The eight mentors mentioned here represent what would be 75% of the planned 11 industry mentors.

Experience by submitting capstone projects and viewing the slide presentation that ASU CGEST created, with 33% of all CompuPower students participating in both activities.

An additional implementation challenge related to the involvement of industry mentors participating in the CompuPower Residency Experience emerged before the pandemic began. ASU CGEST's model included recruiting as many industry mentors from its corporate partners as there were participating CompuPower classes, which for Cohort 1 would have been five industry mentors. Their primary responsibility was to participate in the CompuPower Residency Experience by providing insight into their career pathways and serving as judges for the capstone project presentations. ASU CGEST recruited one industry mentor to participate as part of Cohort 1, but this person understandably was not able to participate actively in the slide presentation that students viewed.

Cohort 2

For Cohort 2 participants, ASU CGEST had more time to transition the CompuPower Residency Experience to a virtual conference format. The CompuPower Residency Experience was offered as a synchronous virtual conference for 3 days in May 2021 using a web-based online conference platform. It included a virtual ASU campus visit, live testimonials from college students, and breakout sessions about STEM careers in fields such as aerospace, genetics, physics, and neuroscience. The online conference platform also allowed students across the participating schools to interact with other students in the CompuPower program, as well as present their final projects to an audience. Although students could not meet at ASU for an in-person campus experience, the CompuPower Residency Experience for Cohort 2 students more closely resembled ASU CGEST's original plan for its implementation. However, as was the case for Cohort 1, the program could not recruit industry mentors to participate in the CompuPower Residency Experience.

Exhibit 6. Table of Implementation Findings

CompuPower key component	Definitions		Cohort 1		Cohort 2		Both cohorts	
	Definition of adequate implementation	Definition of implementation with fidelity at program level	Units[a] with adequate implementation	Implemented with fidelity (Yes/No)	Units with adequate implementation	Implemented with fidelity (Yes/No)	Units with adequate implementation	Implemented with fidelity (Yes/No)
CompuPower course[b]	Percentage of classes in which the number of lessons taught and deliverables assigned met the threshold	75% of classes rated as *adequate*	40%	No	67%	No	55%	No
Mentor teacher professional development[c]	Percentage of teachers who completed professional development activities	75% of teachers rated as *adequate*	80%	Yes	100%	Yes	91%	Yes
Parent Academy[e]	Percentage of students' parents or guardians who attended Parent Academy sessions	75% of parents rated as *adequate*	0%	No	0%	No	0%	No
CompuPower Residency Experience[d]	Percentage of industry mentors and students who completed CompuPower Residency Experience activities	75% of industry mentors rated as *adequate*	0%	No	0%	No	0%	No
		80% of students rated as *adequate*	0%	No	19%	No	8%	

Note. Data are based on authors' analysis of program data collected by ASU CGEST and AIR-administered teacher survey data.

[a] The unit(s) of implementation varied for each key program component. See notes for the unit of implementation for each component. [b] The unit of implementation for the CompuPower Course is the CompuPower class in each participating school. [c] The unit of implementation for the mentor teacher professional development is the mentor teacher. [d] The units of implementation for the CompuPower Residency Experience are industry mentors and students. [e] The unit of implementation for the Parent Academy is the parent/guardian of a CompuPower student.

Implementation Fidelity Summary

Program implementation overall was lower than intended, primarily caused by interruptions to schooling and other in-person gatherings from the COVID-19 pandemic. Across the four key components of the CompuPower program, only the mentor teacher professional development met the criteria for adequate implementation fidelity. The CompuPower course curriculum approached the criteria for adequate implementation fidelity in Cohort 2, even though the course started later than intended (6 weeks into the school year) and endured repeated interruptions to in-person schooling, which teachers reported throughout the year. It is worth noting that the primary responsibility for implementing these two program components fell to ASU CGEST staff and participating mentor teachers.

In contrast, implementing the two components that had the lowest implementation fidelity relied—either in part or full—on adults outside ASU CGEST and participating schools making significant time commitments for program activities. For the Parent Academy, schools could not identify volunteers to offer the program, which we estimate approached 100 hours for travel, training, and program implementation for some school communities. For the CompuPower Residency Experience, ASU CGEST could not garner consistent support from STEM industry professionals to participate in the CompuPower Residency Experience activities, although we recognize that this was not the only challenge to implementation. Overall, the implementation results suggest that relying on significant participation from nonprogrammatic adults—in this case adults who are not ASU CGEST or participating school staff—presented implementation challenges. In contrast, ASU CGEST staff went to considerable efforts to develop meaningful virtual CompuPower Residency Experience program content for both cohorts even under the difficult circumstances presented by the pandemic.

Did CompuPower Change Students' Outcomes?

This section describes the impact of CompuPower on the student outcomes. We first present the results for the confirmatory research question, which focused on self-regulation, and then for the exploratory research questions.

Did CompuPower Affect Students' Self-Regulation?

The confirmatory research question for the impact evaluation asked whether participating in the CompuPower program had an effect on students' self-regulation, which was the social-emotional outcome that ASU CGEST considered essential for determining the program's effectiveness.

Exhibit 7 presents the results from a statistical comparison of the responses of CompuPower and comparison students on the self-regulation measure. The exhibit shows the difference between CompuPower and comparison students, along with other relevant information from the analysis. On average, CompuPower students scored slightly higher than comparison students. Although the difference is not statistically significant (i.e., the *p* value is not less than .05), the effect size, reported here as Hedges' *g*, is 0.14. This is within the range of what Kraft (2019) proposed is a medium effect size for an education intervention. We suggest that this effect is worth noting even though it is not statistically significant given the pronounced implementation challenges posed by the COVID-19 pandemic.

Exhibit 7. Differences in Student Self-Regulation

Outcome measure	Comparison group			CompuPower Group			CompuPower – comparison difference	Hedges' *g*	*p* value
	Sample size	Mean	*SD*	Sample size	Model-adjusted mean	*SD*			
Adolescent Self-Regulation	62	0.94	1.06	161	1.11	1.40	0.17	0.14	0.25

Note. The second column displays the comparison group sample size, and the fifth column displays the CompuPower group sample size, with each reflecting the number of students in the analytic sample. The third and fourth columns display the mean outcome levels and standard deviations for the comparison group, and the sixth and seventh columns display the model-adjusted means and standard deviations for the CompuPower group. The model-adjusted mean is calculated by adding the coefficient for the treatment dummy in the regression model (the impact estimate) to the unadjusted mean for the comparison group. The eighth column is the difference between the CompuPower and comparison means. The ninth column displays Hedges' *g*, which is a standardized effect size that is the equivalent to the group difference divided by the pooled standard deviation of the outcome with a small sample size correction. Effect sizes are comparable across outcomes, even if the outcomes have different scales or dimensions. The tenth column displays the *p* value, which is the probability the estimated group difference would be as large as it is if the true effect was zero. Data are based on authors' analysis of data from AIR-administered student surveys.

Did CompuPower Affect the Exploratory Outcomes?

Exhibit 8 presents the results from a statistical comparison of CompuPower and comparison students on the exploratory social-emotional outcome, critical thinking skills for everyday life, as well as an exploratory academic achievement outcome, students' GPA for the year they participated in the study. CompuPower students scored slightly higher than comparison students on critical thinking skills for everyday life (Hedges' $g = 0.19$), but the difference is not statistically significant. For GPA, CompuPower students' GPA was 0.09 point higher than comparison students (Hedges' $g = .0.11$), but the difference is not statistically significant. The effect sizes for both exploratory outcomes fall within the range for a medium effect size according to Kraft (2019).

Exhibit 8. Differences in Student Academic Achievement Outcome

Outcome measure	Comparison group			CompuPower group			CompuPower – comparison difference	Hedges' *g*	*p* value
	Sample size	Mean	*SD*	Sample size	Model-adjusted mean	*SD*			
Critical Thinking Skills for Everyday Life	62	1.01	0.97	161	1.21	1.34	0.20	0.19	0.16
GPA	61	3.03	0.85	152	3.12	0.64	0.09	0.11	0.32

Note. The second column is the comparison group sample size, and the fifth column is the CompuPower group sample size, with each reflecting the number of students in the analytic sample. The third and fourth columns display the mean outcome levels and standard deviations for the comparison group, and the sixth and seventh columns display the model-adjusted means and standard deviations for the CompuPower group. The model-adjusted mean is calculated by adding the coefficient for the treatment dummy in the regression model (the impact estimate) to the unadjusted mean for the comparison group. The eighth column is the difference between the CompuPower and comparison means. The ninth column displays Hedges' *g*, which is a standardized effect size that is the equivalent to the group difference divided by the pooled standard deviation of the outcome with a small sample size correction. The effect sizes are comparable across outcomes, even if the outcomes have different scales or dimensions. The tenth column displays the *p* value, which is the probability the estimated group difference would be as large as it is if the true effect is zero. Data based on authors' analysis of data from AIR-administered student surveys and school-provided administrative data.

To examine the robustness of the results for all outcomes, we conducted a set of sensitivity analyses using only the student-level baseline measures in the propensity score matching models, instead of using both student-level and school-level baseline measures, which produced different analytic samples for the impact estimation models. Our rationale for this approach was twofold. First, the WWC standards require that we establish baseline equivalence only for the baseline measures of the outcomes, which are measured at the student level. Second, we could not obtain baseline equivalence on all school-level characteristics. The sensitivity impact analyses produced similar results as those described in this section. See Appendix J for details about and the results of the sensitivity analyses.

Limitations

The study has several limitations. First and possibly the most important limitation to the study is the challenge that the COVID-19 pandemic presented to implementing the full CompuPower program as designed. The pandemic interrupted all educational activities—including those related to CompuPower—during both years of the evaluation. ASU CGEST worked diligently to support CompuPower's ongoing implementation by switching to virtual mentor teacher professional development, creating an online version of the CompuPower course content, and creating virtual end-of-year experiences to replace the planned in-person CompuPower Residency Experience. Nevertheless, the pandemic presented many challenges to implementing the program with fidelity. Some teachers did not progress through the course content as expected. Even when teachers could cover most or all the content, at times they had to deliver the course to students who were attending remotely, which was not how the course was designed. Furthermore, although ASU CGEST created a virtual CompuPower Residency Experience that included a robust set of activities, particularly for Cohort 2, it was likely a much different experience for students than spending several days on the ASU campus would have been. Even though the lack of the Parent Academy was not primarily related to the COVID-19 pandemic, the absence of this key program component was likely consequential in terms of the program's effect. Overall, the limited implementation fidelity makes it difficult to generalize the results from this study to a situation when the full program is implemented with fidelity.

Second, because participating high schools offered CompuPower as an elective course, we did not randomly assign students to participate in the program. Although our use of propensity score matching created analytic samples of the CompuPower and comparison groups that met the WWC standards for baseline equivalence on the pretest measures of all outcome variables, as well as other student-level background characteristics, we cannot rule out the possibility of meaningful differences between the two groups on unmeasured characteristics. For example, we know that there were some differences in the school-level characteristics for the two groups of students. Therefore, our estimate of the impact of CompuPower on student outcomes could reflect selection bias and result from unmeasured baseline differences in the CompuPower and comparison groups rather than the impact of program.

Third, recruiting schools to participate in the program proved challenging, limiting the available sample size for the evaluation. Although schools received CompuPower content and materials for free during the year they participated, assigning a mentor teacher and a classroom for the course meant that the educator and space were not available for another class. ASU CGEST reported that even among schools that wanted to participate, making a teacher available for the course was not feasible given staff and funding constraints in many schools. Furthermore, once the COVID-19 pandemic hit and schools faced significant uncertainties for the 2020–21 school year, some schools that had planned to participate withdrew from the study in summer 2020. Relatedly, the participating nine schools may not represent the population of rural schools that ASU CGEST targeted for the study.

Fourth, compounding the recruitment challenge were low rates of parental consent and low survey response rates for students with consent, which limited the sample size even further. As a result, the study sample is likely not representative of the population of students from the participating schools. Our results represent the impact of CompuPower on students whose parents were willing to provide consent for them to participate and who themselves were available and amenable to participate in all data collection activities.

An additional limitation related to the smaller than expected sample size is that it limited our statistical power to detect significant differences between the CompuPower and comparison groups. If the differences we detected in our analyses reflect the true impact of the CompuPower program—and are not caused by selection bias, a limitation we raised previously—our ability to conclude the differences were statistically significant was hampered by the small sample.

Discussion

Despite the limitations, we believe there are lessons to be learned from the impact and the implementation evaluations. Although the program did not have a statistically significant impact on the confirmatory outcome or either exploratory outcome, the effect sizes were in the range for a medium effect size for an educational intervention for all three outcomes. These differences could result from selection bias, as discussed previously, but it is also possible that they reflect the program's potential impact. Furthermore, it is important to note that these effect sizes emerged in the context of significant implementation challenges caused by the COVID-19 pandemic. To better understand CompuPower's effect on student outcomes, future research is needed when the program can be implemented with fidelity and adequate numbers of schools and students can participate in the evaluation.

Despite the challenges of the COVID-19 pandemic, the implementation evaluation results may prove useful to future iterations of the CompuPower program. First, as noted previously, the two components of the program implemented most successfully were the mentor teacher professional development and the CompuPower course. The success of both components relied on the efforts of ASU CGEST staff and the teachers who signed on to teach the course. In contrast, the Parent Academy and the CompuPower Residency Experience relied in whole or part on other adults. For the Parent Academy, the program required other adults volunteering significant time and energy to the program. The structure of the CompuPower Residency Experience relied in part on industry mentors devoting significant time outside their typical professional responsibilities. These results suggest a key factor in the success of educational programs such as CompuPower may include the participation of noneducator adults in sustainable ways. For example, there may be other approaches to involving industry mentors that allow them to work with students in meaningful ways that fit with their other commitments. Similarly, offering workshops to parents in remote communities may require a different model than the one ASU CGEAT planned. It is likely that many adults outside education fields would welcome the opportunity to work with students and their families given the right circumstances.

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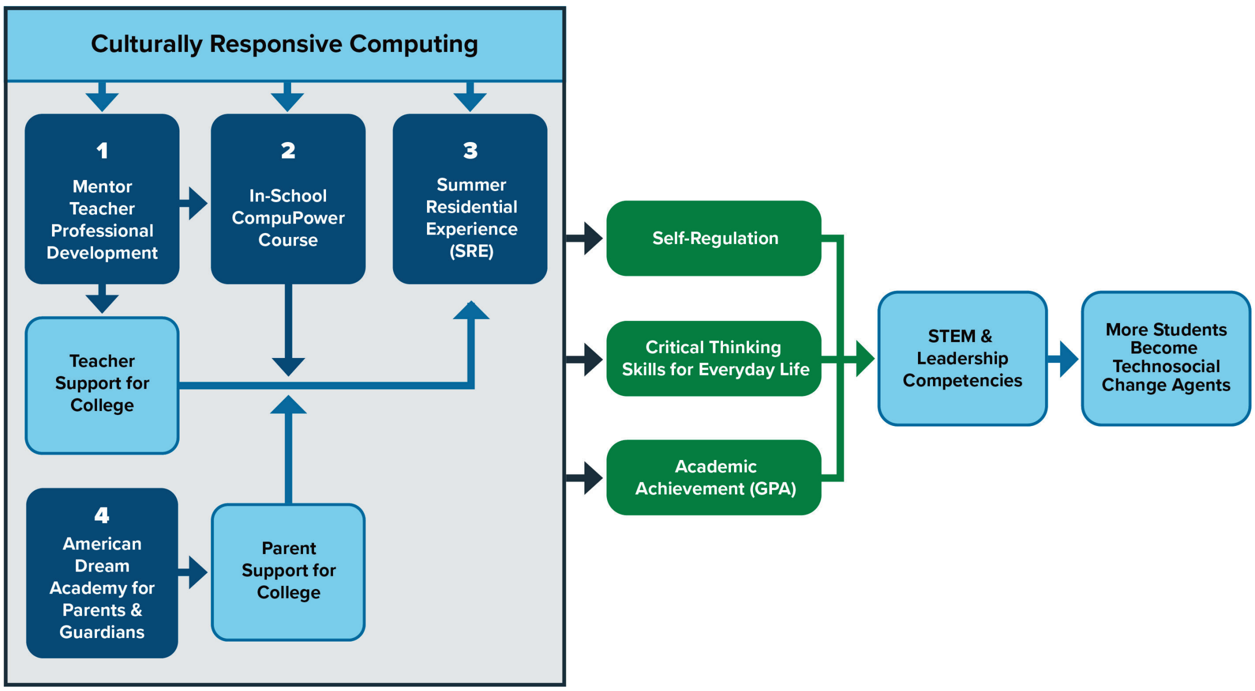
Appendix A. CompuPower Logic Model

The dark blue, numbered boxes in the logic model represent the key components of the CompuPower program that we examined as part of the implementation evaluation. See the main body of the report for more information about each component. The green boxes represent the outcome measures we examined as part of the impact evaluation.



Appendix B. Brief Literature Review on the Causal Effect of Culturally Responsive Education on Student Outcomes

Promising correlational and qualitative evidence suggests that culturally responsive education has a positive impact on a range of student outcomes, including but not limited to student achievement, motivation, empowerment, critical discourse, and agency (Aronson & Laughter, 2016). However, few studies have identified whether culturally responsive education has a causal effect on student outcomes (see Bottiani et al., 2018, for a methodological review of prior research). We focus our review on three recent studies that identified causal effects.

The first causal evidence of the effects of culturally responsive education stems from an evaluation of a high school ethnic studies course in San Francisco, which emphasized themes of social justice, discrimination, stereotypes, social movements, and political struggles in U.S. history (Dee & Penner, 2017). The curriculum also encouraged students to explore their identities and family backgrounds, and to engage in civic life. The students were required to complete a service-learning project. Teachers of the ethnic studies course used teaching methods that were "designed to build on and honor students' cultural assets, experiences, and perspectives; develop their critical consciousness; and create authentic, caring academic environments" (Dee & Penner, 2017, p. 136). Using a regression discontinuity approach, the authors found that assignment to the ethnic studies course increased ninth-grade attendance by 21 percentage points, GPA by 1.4 grade points, and credits earned by 23 (Dee & Penner, 2017). A follow-up study also identified positive effects on longer term outcomes, including high school graduation, attendance, and the probability of enrolling in college (Bonilla et al., 2021).

Two authors from the San Francisco studies recently evaluated the impacts of the African American Male Achievement (AAMA) program in Oakland, a local initiative that is part of the My Brother's Keeper Challenge developed under the Obama administration (Dee & Penner, 2021). The AAMA program includes classes exclusively for Black male students taught by Black male teachers, incorporating social-emotional learning, African American history, culturally relevant pedagogy, and academic supports. Using a difference-in-differences approach, the authors found that the availability of the AAMA program led to a significant reduction in school dropout for Black males, in addition to smaller reductions among Black females.

Although these studies estimated causal effects of interventions, they could not tease apart the components of the interventions. Attending to this gap in the research, a recent experimental study took a multistage analytic approach. First, the author estimated how teachers of color impact their students. After estimating the causal effects of teachers of color on social-emotional, academic, and behavior outcomes of students, the author explained these positive effects by predicting teacher effects with various culturally responsive practices. He found that the teacher effects were

> explained in part by teachers' growth mindset beliefs that student intelligence is malleable rather than fixed, interpersonal relationships with students and families, time spent planning for and differentiating instruction for individual students' needs, and the extent to which teachers lead well-organized classrooms in which student (mis)behavior is addressed productively without creating a negative classroom climate (Blazar, 2021, abstract).

Appendix C. CompuPower Course Learning Objectives

This appendix presents the complete list of learning objectives for the CompuPower course curriculum. The learning objectives are organized by quarter and unit.

Exhibit C1. CompuPower Course Learning Objectives, Quarter 1

Unit	Objectives
1.1	• Students will be able to participate in a discussion on the course objectives. • Students will be able to identify and agree upon classroom norms. • Students will be able to identify and use for discussion an object of personal importance. • Students will be able to define the term “power” as it is used in the CompuPower course.
1.2	• Students will be able to participate in a discussion on the meaning of culturally responsive education. • Students will be able to describe the identity characteristics of other people. • Students will be able to read, discuss, and reflect on the characteristics of STEM leaders. • Students will be able to describe their own identity characteristics. oStudents will be able to download and save images from the Internet.
1.3	• Students will be able to write a letter describing their current power skills and characteristics, technology identity, and intent to participate in positive social change. • Students will be able to discuss the concept of “digital footprint” and create guidelines for Internet use based on that concept. oStudents will be able to reflect on the concept of “website bias.” • Students will be able to create a Google Drive account and save documents in it. • Students will be able to upload, rotate, arrange, and resize public domain (or correctly attributed) images on a digital collage.
1.4	• Students will be able to create a post in a digital journal application. oStudents will be able to define the terms privilege and intersectionality. • Students will be able to demonstrate the relationship among the term identity, privilege, and intersectionality. • Students will be able to identify examples of privilege and intersectionality
1.5	• Students will be able to conduct online research to determine career fields of interest. • Students will be able to identify leaders in a selected career field. • Students will be able to determine positive and negative elements of a website. • Students will be able to draft content for an online portfolio website. • Students will be able to use a website builder to create a portfolio website that showcases their professional identity, knowledge, and work to potential employers/clients/collaborators, to include a landing page and four (4) quarterly reflection pages.

Exhibit C2. CompuPower Course Learning Objectives, Quarter 2

Unit	Objectives
2.1	• Students will be able to participate in a discussion on power and community. • Students will be able to define the concept of community as it is used in the CompuPower course. • Students will learn to apply intersectionality to critique the impact on community representation and misrepresentation.
2.2	• Students will be able to participate in a discussion on digital storytelling—application, relevance. • Students will be able to describe the identity characteristics of other people through storytelling. • Students will be able to read, discuss, and reflect on family/kinship from a critical perspective.
2.3	• Students will be able to conduct interviews—developing questions, soliciting volunteers. • Students will be able to discuss how power influences the dynamics of a community. • Students will be able to discuss how interviews can be a tool to address power issues in a community.
2.4	• Students will be able to create a post in a digital journal application. • Students will be able to identify different types of stories and techniques used to construct a digital story (i.e. storyboarding). • Students will be able to analyze power through technology and its impact on the community.
2.5	• Students will be able to determine the positive and negative elements of digital storytelling. • Students will be able to create a digital storytelling video. • Students will be able to use the digital story video to create a portfolio website that showcases their professional identity, knowledge, and work.

Exhibit C3. CompuPower Course Learning Objectives, Quarter 3

Unit	Objectives
3.1	• Students will be able to participate in a discussion on the influence of power to shape perceptions about place. • Students will be able to define the concept of place as it is used in the CompuPower course. • Students will learn to apply intersectionality and stereotyping to critique the relationship between place and power.
3.2	• Students will be able to participate in a discussion on power versus authority and the influence on place. • Students will be able to differentiate between coalition and collaboration. • Students will be able to read, discuss, and reflect on coalition and collaboration from a critical perspective.
3.3	• Students will be able to develop a list of possible school issues which could become a primary goal for a coalition to work toward solving. • Students will be able to identify family, school, and community leaders who might be a valuable member of a coalition working toward solving a specific goal. • Students will be able to use an online Project Management Application to list, assign, and track the progress of their project goals.
3.4	• Students will be able to determine possible causes that might be affecting their selected school issue. • Students will be able to develop specific, measurable goals leading to a possible solution for their selected school issue. • Students will be able to use an online Project Management Application to list, assign, and track the progress of their project goals.
3.5	• Students will be able to develop and discuss a plan for creating a flyer advertising some aspect of their coalition project using an online infographics design application. • Students will be able to develop and discuss a plan for creating a public service announcement video advertising some aspect of their coalition project incorporating the use of Rhetorical appeals using video capture and editing applications. • Students will be able to create an infographic using an online infographic design application to visualize relevant facts that support their coalition project.
3.6	• Students will be able to create a flyer advertising some aspect of their coalition project using an online infographics design application. • Students will be able to create a public service announcement video advertising some aspect of their coalition project incorporating the use of Rhetorical appeals using video capture and editing applications. • Students will be able to embed an infographic that supports their coalition project into a flyer, public service announcement video, or both.

Exhibit C4. CompuPower Course Learning Objectives, Quarter 4

Unit	Objectives
4.1	• Students will be able to develop a digital survey to be implemented with local community members. • Students will be able to list at least three new things they learned about coding to include something about computer bias (algorithmic bias). • Students will be able to create a rudimentary HTML document and view it through an Internet browser.
4.2	• Students will be able to select which evidence they will use to demonstrate community engagement and which coalition members will be responsible for ensuring those pieces of evidence are professionally developed. • Students will be able to create a presentation using a tri-fold board that showcases the background, project plan, and community engagement for a community project. • Students will be able to create a rough draft oral presentation “pitch” that uses rhetorical appeals to persuade an audience to join their coalition. • Students will be able to provide concrete feedback on other coalition presentations to include positive aspects and aspects that need revision.
4.3	• Students will be able to participate in a discussion on the influence of power to shape perceptions about technology. • Students will be able to analyze data through an intersectional lens and respond with an action plan to address social issues. • Students will learn to develop SMART goals for their coalition projects that critique the relationship between technology and power.
4.4	• Students will be able to finalize their coalition projects in preparation for the SRE.
4.5	• Students will be able to reflect on the CompuPower course, their power, and their future selves.

Appendix D. Participating Schools' Locale and Rural Classification

Exhibit D1 lists the schools that participated in each cohort; their locale classification according to the NCES; and whether each school's LEA met the rural criteria established in the notice inviting applications, which is defined as being eligible for the Small Rural School Achievement program or the Rural and Low-Income School Program.

Exhibit D1. Locale Classifications of Participating Schools

Cohort	School	Locale classification	School's LEA met rural criteria
Cohort 1, 2019–20 school year	Apache Trail High School	Suburb: Large	Yes
	Miami High School	Rural: Fringe	Yes
	Pima High School	Town: Remote	Yes
	Sequoia Pathways High School	Town: Distant	Yes
	Show Low High School	Rural: Fringe	Yes
Cohort 2, 2020–21 school year	Berean Academy	City: Small	Yes
	Learning Foundation and Performing Arts[a]	Suburb: Large	No
	Mayer High School	Rural: Distant	Yes
	Miami High School	Rural: Fringe	Yes
	Northland Prep	City: Small	Yes
	Show Low High School	Rural: Fringe	Yes

Note. Data are based on Common Core of Data (2019–20) and Rural Education Achievement Program (REAP) eligibility spreadsheets for fiscal years 2019 and 2020.

[a] This school shares a name with another school in the state. The school that did not participate in the study was part of an LEA eligible for the REAP program in 2020, whereas the participating school was not. As a result, the school in the evaluation did not meet the rural criteria.

Appendix E. Data Collection Instruments

This appendix includes the full student survey and a section of the teacher survey that AIR administered as part of the study.

Student Survey

Students completed the student survey prior to the CompuPower course before participating in any CompuPower course lessons and at the end of the school year. The following sections include the survey instructions as well as all items and the respective response scales students used to answer the survey items.

Adolescent Self-Regulation Scale

Please indicate how true each of the following statements is for you on a scale of 1 to 5, where 1 means it is not at all true for you and 5 means it is really true for you. For each question, select the response that best describes you. There are no right or wrong answers to the questions.

	Not at all true for me (1)	Not very true for me (2)	Neither true or untrue for me (3)	Somewhat true for me (4)	Really true for me (5)
1. If something isn't going according to my plans, I change my actions to try and to reach my goal.	○	○	○	○	○
2. I can find ways to make myself study even when my friends want to go out.	○	○	○	○	○
3. If I really want something, I have to have it right away.[a]	○	○	○	○	○
4. When I have a serious disagreement with someone, I can talk calmly about it without losing control.	○	○	○	○	○
5. I can stay focused on my work even when it's dull.	○	○	○	○	○
6. I lose control whenever I don't get my way.[a]	○	○	○	○	○
7. I can stop myself from doing things like throwing objects when I'm mad.	○	○	○	○	○
8. I work carefully when I know something will be tricky.	○	○	○	○	○
9. I am usually aware of my feelings before I let them out.	○	○	○	○	○

	Not at all true for me (1)	Not very true for me (2)	Neither true or untrue for me (3)	Somewhat true for me (4)	Really true for me (5)
10. In class, I can concentrate on my work even if my friends are talking.	○	○	○	○	○
11. When I'm excited about reaching a goal (e.g., getting my driver's license, going to college), it's easy to start working toward it.	○	○	○	○	○
12. I can find a way to stick with my plans and goals, even when it's tough.	○	○	○	○	○
13. When I have a big project, I can keep working on it.	○	○	○	○	○
14. I can resist doing something when I know I shouldn't do it.	○	○	○	○	○

[a] We reverse coded item 3 and item 6 before conducting any analyses.

Critical Thinking Skills for Everyday Life Scale

The following statements describe how you might think about things in your daily life. Select that answer that corresponds to how often you have done what is described in the last 30 days.

	Never	Rarely	Sometimes	Often	Always
15. I think of possible outcomes before I take action.	○	○	○	○	○
16. I get ideas from other people when having a task to do.	○	○	○	○	○
17. I develop my ideas by gathering information.	○	○	○	○	○
18. When facing a problem, I identify options.	○	○	○	○	○
19. I can easily express my thoughts on a problem.	○	○	○	○	○
20. I am able to give reasons for my opinions.	○	○	○	○	○
21. It is important for me to get information to support my opinions.	○	○	○	○	○
22. I usually have more than one source of information before making a decision.	○	○	○	○	○
23. I plan where to get information on a topic.	○	○	○	○	○
24. I plan how to get information on a topic.	○	○	○	○	○
25. I put my ideas in order by importance.	○	○	○	○	○

	Never	Rarely	Sometimes	Often	Always
26. I back my decisions by the information I collect.	○	○	○	○	○
27. I listen to the ideas of others even if I disagree with them.	○	○	○	○	○
28. I compare ideas when thinking about a topic.	○	○	○	○	○
29. I keep my mind open to different ideas when planning to make a decision.	○	○	○	○	○
30. I am aware that sometimes there are no right or wrong answers to a question.	○	○	○	○	○
31. I develop a checklist to help me think about a problem.	○	○	○	○	○
32. I can easily tell what I did was right or wrong.	○	○	○	○	○
33. I am able to tell the best way of handling a problem.	○	○	○	○	○
34. I make sure the information I use is correct.	○	○	○	○	○

Academic Possible Selves Scale

Please indicate how much you agree with each of the following statements on a scale of 1 to 7, where 1 means you strongly disagree and 7 means you strongly agree. For each question, select the response that best describes you. There are no right or wrong answers to the questions.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
35. I am confident that I can pay more attention in class next year.	○	○	○	○	○	○	○
36. Throughout next year I will look for help when I face problems in improving my classroom grades.	○	○	○	○	○	○	○
37. Throughout next year I will seek ways to create a better plan for paying more attention in class.	○	○	○	○	○	○	○

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
38. Throughout next year I will seek ways to create a better plan for improving my classroom grades.	○	○	○	○	○	○	○
39. I am confident that I can be a better student next year.	○	○	○	○	○	○	○
40. Throughout next year I will look for help when I face problems in being a better student.	○	○	○	○	○	○	○
41. Throughout next year I will assess how much I pay attention in class.	○	○	○	○	○	○	○
42. I am confident that I will have a plan to pay more attention in class next year.	○	○	○	○	○	○	○
43. I can see myself being a better student next year.	○	○	○	○	○	○	○
44. Throughout next year I will evaluate my plan to improve my classroom grades.	○	○	○	○	○	○	○
45. I am confident that I can improve my classroom grades next year.	○	○	○	○	○	○	○
46. I can see myself paying more attention in class next year.	○	○	○	○	○	○	○
47. I am confident that I will have a plan to improve my classroom grades next year.	○	○	○	○	○	○	○
48. I can see myself improving my classroom grades next year.	○	○	○	○	○	○	○

Teacher Survey

Each quarter, AIR asked CompuPower mentor teachers to complete a short online survey about the CompuPower lessons they taught in the most recent academic quarter. Teachers also were asked to report on the deliverables that students completed for each lesson. The following provides a sample set of questions that teachers completed for each unit.

Questions About CompuPower Lessons

Which lessons in Unit 1.1 (CompuPower Expectations) have you taught?

	I taught this lesson
Introduction to CompuPower	○
Introduction to the CompuPower Residency Experience	○
Establishing Class Norms	○
Power Object	○
What Is Power?	○

Questions About CompuPower Deliverables

How many students submitted a satisfactory assignment for the following Unit 1.1 (CompuPower Expectations) student deliverables?

	0%–25% of my students	26%–50% of my students	51%–75% of my students	76%–100% of my students	I did not assign this student deliverable
Syllabus	○	○	○	○	○
Power Definition	○	○	○	○	○

Appendix F. Psychometric Analysis of Student Social-Emotional Outcome Measures

To ensure that the three survey measures had adequate internal reliability for the students in this study, AIR applied exploratory factor analyses and partial credit modeling analyses to each original survey scale using the combined pre- and posttest student survey data. For the impact analyses, we created scale scores, retaining only those items with factor loadings ≥ .40 and item infit and outfit mean square values between 0.5 and 1.5 (Wright, 1994). Exhibit F1 presents the correlation matrix of the pretest (or baseline) and posttest measures of the three survey scale scores and GPA and their means and standard deviations.

Exhibit F1. Correlations, Means, and Standard Deviations for the Social-Emotional Survey Measures and Grade Point Average

	Mean	*SD*	*N*	1	2	3	4	5	6
1. Self-Regulation Pretest	1.10	0.99	731	—					
2. Self-Regulation Posttest	1.24	1.18	359	0.66	—				
3. Academic Possible Selves	2.29	2.13	729	0.59	0.35	—			
4. Critical Thinking Skills for Everyday Life Posttest	1.13	1.24	352	0.40	0.73	0.60	—		
5. Prior year GPA	3.03	0.87	480	0.22	0.05	0.08	-0.01	—	
6. Current year GPA	2.97	0.92	498	0.17	0.22	0.09	0.10	0.55	—

Note. SD = standard deviation; GPA = grade point average.

Self-Regulation

Cronbach's alpha for the subset of items from the Adolescent Self-Regulatory Inventory survey (Moilanen, 2007) used in this study was 0.79. Factor loadings ranged from 0.40 to 0.60; both item infit and outfit mean square estimations ranged between 0.71 and 1.48. Exhibit F2 presents the psychometric statistics for the subset of adolescent self-regulation survey used in this study.

Exhibit F2. Item Factor Loadings and Fit Statistics for the Items Used to Measure Self-Regulation

Item number	Item	Factor loading	Infit mean square	Outfit mean square
1	If something isn't going according to my plans, I change my actions to try and to reach my goal.	0.55	0.80	0.84
2	I can find ways to make myself study even when my friends want to go out.	0.54	1.08	1.06
8	I work carefully when I know something will be tricky.	0.59	0.81	0.81
9	I am usually aware of my feelings before I let them out.	0.40	1.48	1.48
10	In class, I can concentrate on my work even if my friends are talking.	0.48	1.04	1.04
11	When I'm excited about reaching a goal (e g , getting my driver's license, going to college), it's easy to start working toward it.	0.58	1.05	1.05
12	I can find a way to stick with my plans and goals, even when it's tough.	0.68	0.71	0.71
13	When I have a big project, I can keep working on it.	0.68	0.79	0.79
14	I can resist doing something when I know I shouldn't do it.	0.49	1.20	1.21

Note. We excluded survey items 3, 4, 5, 6, and 7 from the original adolescent self-regulation scale.

Critical Thinking Skills for Everyday Life Survey

Cronbach's alpha for the subset of items from the Critical Thinking Skills for Everyday Life survey (Mincemoyer & Perkins, 2005) used in this study was 0.89. Factor loadings for these items ranged from 0.40 to 0.65; item infit and outfit mean square estimations ranged between 0.77 and 1.43. Exhibit F3 presents the psychometric statistics for the subset of critical thinking skills items that we used in this study.

Exhibit F3. Item Factor Loadings and Fit Statistics for the Subset of Critical Thinking Skills for Everyday Life Survey

Item number	Item	Factor loading	Infit mean square	Outfit mean square
15	I think of possible outcomes before I take action.	0.65	0.92	1.00
17	I develop my ideas by gathering information.	0.55	0.84	0.84
18	When facing a problem, I identify options.	0.64	0.92	0.94
19	I can easily express my thoughts on a problem.	0.53	1.30	1.33
20	I am able to give reasons for my opinions.	0.55	1.01	0.99

Item number	Item	Factor loading	Infit mean square	Outfit mean square
21	It is important for me to get information to support my opinions.	0.61	1.00	0.95
22	I usually have more than one source of information before making a decision.	0.62	0.94	0.92
23	I plan where to get information on a topic.	0.56	1.03	1.03
24	I plan how to get information on a topic.	0.65	0.95	0.94
25	I put my ideas in order by importance.	0.49	1.30	1.33
26	I back my decisions by the information I collect.	0.63	0.77	0.77
27	I listen to the ideas of others even if I disagree with them.	0.45	1.17	1.12
28	I compare ideas when thinking about a topic.	0.53	0.80	0.78
29	I keep my mind open to different ideas when planning to make a decision.	0.52	0.93	0.89
30	I am aware that sometimes there are no right or wrong answers to a question.	0.40	1.43	1.41
32	I can easily tell what I did was right or wrong.	0.45	1.13	1.22
33	I am able to tell the best way of handling a problem.	0.53	0.79	0.89
34	I make sure the information I use is correct.	0.55	0.78	0.77

Note. We excluded survey items 16 and 31 from the original Critical Thinking Skills for Everyday Life scale.

Academic Possible Selves Survey

Cronbach's alpha for the subset of items from the Persistent Academic Possible Selves Scale for Adolescents (Lee et al., 2016) used in this study was 0.96. Factor loadings ranged from 0.71 to 0.84; item infit and outfit mean square estimations ranged from 0.70 to 1.50. Exhibit F4 presents the psychometric statistics for the subset of academic possible selves survey used in this study.

Exhibit F4. Item Factor Loadings and Fit Statistics for the Subset of Academic Possible Selves Survey

Item number	Item	Factor loading	Infit mean square	Outfit mean square
35	I am confident that I can pay more attention in class next year.	0.71	1.29	1.50
36	Throughout next year I will look for help when I face problems in improving my classroom grades.	0.74	1.20	1.24
37	Throughout next year I will seek ways to create a better plan for paying more attention in class.	0.79	0.89	0.92
38	Throughout next year I will seek ways to create a better plan for improving my classroom grades.	0.79	0.93	0.82
39	I am confident that I can be a better student next year.	0.77	1.28	1.11
40	Throughout next year I will look for help when I face problems in being a better student.	0.77	0.98	1.04
41	Throughout next year I will assess how much I pay attention in class.	0.75	1.09	1.14
42	I am confident that I will have a plan to pay more attention in class next year.	0.78	1.12	1.10
43	I can see myself being a better student next year.	0.80	1.13	1.02
44	Throughout next year I will evaluate my plan to improve my classroom grades.	0.84	0.82	0.81
45	I am confident that I can improve my classroom grades next year.	0.79	0.90	0.80
46	I can see myself paying more attention in class next year.	0.83	0.81	0.78
47	I am confident that I will have a plan to improve my classroom grades next year.	0.83	0.89	0.85
48	I can see myself improving my classroom grades next year.	0.81	0.82	0.70

Note. We did not exclude any items from the subset of possible academic selves items that we administered. As discussed previously, the full scale includes 51 items. After administering the full scale in spring 2019, we selected a subset of items for future administrations to reduce the time students needed to complete the survey.

Appendix G. Statistical Models

This appendix describes the analytic models used to estimate propensity scores and treatment effect on outcomes.

Propensity Score Model

To estimate propensity scores, students' probabilities of participating in the CompuPower program, AIR pooled the Cohorts 1 and 2 students together and employed the following fixed effect logistic regression model for survey outcomes and student academic performance outcome (i.e., GPA) separately:

$$logit\ (T_{ij}) = \beta_0^{ps} + \beta_1^{ps}\boldsymbol{X_{ij}} + \beta_2^{ps}\boldsymbol{W_j} + \beta_3^{ps}Grade_{ij} + \beta_4^{ps}Cohort_{ij}$$

T_{ij} is the binary variable to indicate if student *i* in school *j* participates in the program; β_0^{ps} is the overall intercept probability of participating in the program; $\boldsymbol{X_{ij}}$ is a vector of student-level baseline measures[19] for student *i* in school *j,* including baseline self-regulation and Academic Possible Selves Survey scores, unweighted GPA at previous school year, gender, race/ethnicity, English learner status, and free or reduced-price lunch status; $\boldsymbol{W_j}$ is a vector of school-level baseline measures[20] for school *j*, including school-level mean baseline self-regulation and Academic Possible Selves Survey scores, school-level mean for previous year's unweighted GPA, charter school indicator, the percentage of female students, the percentage of students in the free or reduced-price lunch program, the percentage of Hispanic students, the percentage of White students, the percentage of Black students, the total number of enrolled students, the 4-year graduation rate, and the dropout rate; $Grade_{ij}$ and $Cohort_{ij}$ are the grade and cohort fixed effects for students *i* in school *j* and used for controlling cluster effects.

Impact Analysis Model

The research team conducted impact analysis for each outcome separately using a two-level linear model with the treatment effect fixed across schools and students nested within schools. The model included all baseline covariates used in the propensity score models. Of note, the research team imputed free or reduced-price lunch and English learner status using the dummy variable imputation method.

[19] When determining baseline equivalence, the AIR research team excluded five available student-level background characteristics due to their low frequency: English learner status, whether the student was Black, whether the student was Asian, whether the student was American Indian or Alaska Native, and whether the students was of two or more races.
[20] When determining baseline equivalence, the AIR research team excluded two available school-level characteristics from baseline checking due to their low frequency: school percentage of Asian students and percentage of students with English learner status.

$$Y_{ij} = \gamma_{00} + \gamma_{01}\boldsymbol{W_j} + \gamma_{02}Grade_{ij} + \gamma_{03}Cohort_{ij} + \gamma_{10}\,T_{ij} + \gamma_{20}\,\boldsymbol{X_{ij}} + u_j + \varepsilon_{ij}$$

Y_{ij} is the outcome score for student *i* in school *j* measured at the end of the school year; T_{ij} is the binary variable to indicate if student *i* in school *j* receives the program intervention; $\boldsymbol{X_{ij}}$ is a vector of the baseline measures for student *i* in school *j,* including all student-level baseline measures used in the propensity score model; $\boldsymbol{W_j}$ is a vector of school-level fixed baseline measures for school *j*, including school-level baseline measures used in the propensity score model (i.e., W_j); $Grade_{ij}$ and $Cohort_{ij}$ are the grade and cohort fixed effects; and u_j and ε_{ij} are the school- and student- level residual effects (i.e., random errors), respectively. The main parameter of interest is γ_{10} which represents the estimated intervention effect on the outcome variable.

Appendix H. Analysis of Baseline Equivalence

To determine whether the propensity score matching created analytic samples with equivalent CompuPower and comparison groups, we examined the standardized mean differences (SMD) between the two groups using criteria established by the WWC. The WWC assesses baseline equivalence on each outcome measure to determine whether baseline differences are small, moderate, or large.

- WWC considers a baseline difference to be small if the SMD is less than |.05|. With a small SMD, the groups are equivalent.
- WWC considers a baseline difference to be moderate if the SMD is greater than |.05| but less than |.25|. With a moderate SMD, the analysis must include the baseline measure as a covariate to meet WWC standards.
- WWC considers a baseline difference to be large if the SMD is greater than |.25|. With a large SMD, the difference at baseline is too large to meet WWC standards.

Exhibits H1 and H2 present the baseline characteristics for the CompuPower and comparison groups before and after the propensity score matching. The last column in each exhibit shows the SMD between the two groups in the final analytic sample; for continuous measures, this is Hedges' *g*; for dichotomous measures, this is Cox's index. After propensity score matching, we removed all unmatched comparison students to create the final analytic samples for data analysis.

Exhibit H1. Baseline Equivalence for the Sample Used in the Social-Emotional Outcome Analyses

Covariates	Before matching					After matching				
	CompuPower (*N* = 62)		Comparison (*N* = 277)		SMD	CompuPower (*N* = 62)		Comparison (*N* = 161)		SMD
	Mean	*SD*	Mean	*SD*		Mean	*SD*	Mean	*SD*	
Student-level variables										
Baseline SR	0.95	1.10	1.13	1.03	-0.17	0.95	1.10	0.86	0.91	0.10
Baseline APS	2.03	2.06	2.30	2.28	-0.12	2.03	2.06	1.83	2.15	0.09
Previous year GPA	3.15	0.75	3.15	0.81	0.00	3.15	0.75	3.17	0.69	-0.03
Female (%)	0.50	0.50	0.61	0.49	-0.28	0.50	0.50	0.51	0.50	-0.03
Free or reduced-price lunch (%)	0.44	0.50	0.50	0.50	-0.15	0.44	0.50	0.51	0.50	-0.18
Hispanic (%)	0.23	0.42	0.18	0.38	0.18	0.23	0.42	0.16	0.37	0.24
White (%)	0.73	0.45	0.74	0.44	-0.06	0.73	0.45	0.79	0.41	-0.20
School-level variables										
School-level baseline SR[a]	1.05	0.42	0.98	0.24	0.24	1.05	0.42	0.94	0.34	0.29
School-level baseline APS[b]	2.08	0.59	2.18	0.49	-0.18	2.08	0.59	1.93	0.48	0.31
School-level previous GPA[c]	3.07	0.36	3.08	0.35	-0.02	3.07	0.36	3.07	0.31	0.00
School-level graduation rate	87.14	12.64	88.12	12.81	-0.08	87.14	12.64	88.46	11.15	-0.11
School-level dropout rate	2.79	3.32	2.22	3.35	0.17	2.79	3.32	2.29	2.87	0.17
Charter school (%)	0.50	0.50	0.38	0.49	0.31	0.50	0.50	0.50	0.50	0.01
Percentage of female students in the school	48.70	4.53	49.27	4.11	-0.13	48.70	4.53	49.86	5.02	-0.24

Covariates	Before matching					After matching				
	CompuPower (*N* = 62)		Comparison (*N* = 277)		SMD	CompuPower (*N* = 62)		Comparison (*N* = 161)		SMD
	Mean	*SD*	Mean	*SD*		Mean	*SD*	Mean	*SD*	
Percentage of students qualifying for free or reduced-price lunch in the school	41.96	20.90	33.82	14.99	0.50	41.96	20.90	39.05	19.45	0.15
Percentage of Hispanic students in the school	31.94	13.57	25.68	13.01	0.48	31.94	13.57	31.77	14.01	0.01
Percentage of White students in the school	55.59	13.95	64.04	15.22	-0.56	55.59	13.95	55.81	14.51	-0.02
Percentage of Black students in the school	3.66	3.92	2.60	3.55	0.29	3.66	3.92	3.70	4.01	-0.01
Total number of students in the school	492.84	263.23	599.82	267.91	-0.40	492.84	263.23	545.88	275.79	-0.19

Note. N is the number of students; SD = standard deviation; SMD is standardized mean difference, which is the baseline mean difference converted into standard deviation units using Hedges' *g* for continuous measures or Cox's Index for dichotomous measures; SR = self-regulation; APS = academic possible selves; GPA = grade point average.

[a] The school-level mean of students' self-regulation scale scores. [b] The school-level mean of students' academic possible selves scale scores. [c] The school-level mean of students' GPA for the previous school year.

Exhibit H2. Baseline Equivalence for the Sample Used in the Academic Outcome Analysis

Covariates	Before matching					After matching				
	CompuPower (*N* = 61)		Control (*N* = 282)		SMD	CompuPower (*N* = 61)		Control (*N* = 152)		SMD
	Mean	*SD*	Mean	*SD*		Mean	*SD*	Mean	*SD*	
Student-level variables										
Baseline SR	1.00	1.16	1.15	1.11	-0.14	1.00	1.16	0.92	1.00	0.07
Baseline APS	2.24	2.14	2.27	2.28	-0.01	2.24	2.14	1.86	2.00	0.18
Previous year GPA	3.06	0.79	2.98	0.93	0.09	3.06	0.79	2.94	0.77	0.16
Female (%)	0.51	0.50	0.56	0.50	-0.13	0.51	0.50	0.48	0.50	0.08
Free or reduced-price lunch (%)	0.39	0.49	0.42	0.49	-0.06	0.39	0.49	0.43	0.50	-0.09
Hispanic (%)	0.21	0.41	0.20	0.40	0.05	0.21	0.41	0.16	0.36	0.23
White (%)	0.69	0.47	0.73	0.44	-0.12	0.69	0.47	0.77	0.43	-0.25
School-level variables										
School-level baseline SR[a]	1.09	0.45	1.00	0.28	0.31	1.09	0.45	1.01	0.37	0.20
School-level baseline APS[b]	2.12	0.63	2.14	0.48	-0.04	2.12	0.63	1.95	0.45	0.35
School-level previous GPA[c]	3.05	0.39	2.97	0.44	0.18	3.05	0.39	2.98	0.38	0.18
School-level graduation rate	85.78	14.23	83.28	19.56	0.13	85.78	14.23	86.52	14.74	-0.05
School-level dropout rate	3.19	3.74	3.56	5.17	-0.07	3.19	3.74	2.89	3.82	0.08
Charter school (%)	0.44	0.50	0.38	0.49	0.16	0.44	0.50	0.35	0.48	0.24
Percentage of female students in the school	47.23	2.78	47.57	2.75	-0.12	47.23	2.78	47.15	3.13	0.03
Percentage of students qualifying for free or reduced-price lunch in the school	44.28	22.15	37.05	18.76	0.37	44.28	22.15	44.53	25.27	-0.01

Covariates	Before matching					After matching				
	CompuPower (*N* = 61)		Control (*N* = 282)		SMD	CompuPower (*N* = 61)		Control (*N* = 152)		SMD
	Mean	*SD*	Mean	*SD*		Mean	*SD*	Mean	*SD*	
Percentage of Hispanic students in the school	31.61	13.97	26.47	13.39	0.38	31.61	13.97	29.77	14.70	0.13
Percentage of White students	56.63	14.43	64.03	14.79	-0.50	56.63	14.43	59.77	15.03	-0.21
Percentage of Black students	3.05	3.60	1.93	2.77	0.38	3.05	3.60	1.96	2.80	0.36
Total number of students in the school	483.26	278.37	554.89	299.54	-0.24	483.26	278.37	504.50	307.14	-0.07

Note: *N* is the number of students; *SD* = standard deviation; SMD = standardized mean difference, which is the baseline mean difference converted into standard deviation units using Hedges' *g* for continuous measures or Cox's Index for dichotomous measures; SR = self-regulation; APS = academic possible selves; GPA = grade point average.

[a] The school-level mean of students' self-regulation scale scores. [b] The school-level mean of students' academic possible selves scale scores. [c] The school-level mean of students' GPA for the previous school year.

Appendix I. Fidelity Measurement

This appendix describes the implementation fidelity data sources for all four key components of the CompuPower program, how we calculated scores for the levels of implementation data, and the threshold for determining whether each component was implemented at the level we defined a priori as "adequate implementation." Although AIR and ASU CGEST collaborated to plan, collect, and analyze implementation fidelity data, ASU CGEST determined the criteria for measuring what accounted for high, medium, and low implementation, as well as the criteria for whether there was an adequate level of implementation for each component.

CompuPower Course Curriculum

We measured implementation fidelity of the CompuPower course curriculum by having teachers complete a brief survey at the end of each academic quarter. The teacher survey consisted of two checklists: a list of all CompuPower lessons in the curriculum and a list of all student deliverables (or assignments) in the curriculum. At the end of each quarter, teachers accessed the online survey and indicated which lessons they taught during that quarter and which student deliverables they assigned.

AIR used the teacher survey responses to calculate scores based on the number of lessons that teachers taught and the number of student deliverables that they assigned. ASU CGEST determined that teachers could be scored as having low, medium, or high in terms of the number of lessons taught or student deliverables assigned, as follows:

- For lessons taught, teachers received a score of
  - 0 (low implementation) for presenting 0%–50% of the lessons,
  - 1 (medium implementation) for presenting 51%–80% of the lessons, and
  - 2 (high implementation) for presenting 81%–100% of the lessons.
- For student deliverables assigned, teachers received a score of
  - 0 (low implementation) for assigning 0%–25% of the student deliverables,
  - 1 (medium implementation) for assigning 26%–75% of the student deliverables, and
  - 2 (high implementation) for assigning 76%–100% of the student deliverables.

For an individual teacher to meet the threshold for "implemented with fidelity," their score based on the percentage of lessons taught and student deliverables assigned had to be 3 or greater. For this program component to be implemented with fidelity for the full sample, more than 75% of all teachers needed to meet the threshold for implementation fidelity.

Mentor Teacher Professional Development

As part of the mentor teacher professional development, teachers were expected to participate in an introductory training on CompuPower theory and practice, complete a set of online asynchronous activities, and attend quarterly check-ins with ASU CGEST staff.

AIR used attendance records to calculate scores based on the number of professional development activities that each teacher attended. ASU CGEST set the following criteria for assigning scores for mentor teachers' participation in the professional development activities.

- For the introductory training, teachers received a score of
  - 1 for attending the training or
  - 0 for not attending the training.
- For the online asynchronous activities, teachers received a score of
  - 2 for completing at least 75% of the activities
  - 1 for completing 50%–74% of the activities, or
  - 0 for completing less than 50% of the activities.
- For the quarterly check-ins, teachers received a score of
  - 1 for attending two or more of the check-ins or
  - 0 for attending less than two of the check-ins.

For an individual teacher to meet the threshold for "implemented with fidelity," their score across all three professional development activities had to be 3 or greater. For this program component to be implemented with fidelity for the full sample, more than 75% of the mentor teachers needed to meet the threshold for implementation fidelity.

CompuPower Residency Experience

The CompuPower Residency Experience component of the program required participation from industry mentors and students. AIR used CompuPower Residency Experience attendance and participation records to calculate scores based on industry mentors' and students' participation in the CompuPower Residency Experience activities. ASU CGEST set the following criteria for assigning scores for these activities.

- Industry mentors received a score of
  - 2 for attending all 3 days of the CompuPower Residency Experience,
  - 1 for attending 2 days, or
  - 0 for attending 1 or no days.
- Students received a score of
  - 1 for attending all 3 days of the CompuPower Residency Experience or
  - 0 for attending fewer than 3 days.
- Students also received a score of
  - 1 for producing a project to be presented at the CompuPower Residency Experience or
  - 0 for not producing a project.

For an individual industry mentor to meet the implementation fidelity threshold, they had to receive a score of 2 indicating that they attended all 3 days of the CompuPower Residency Experience. For an individual student to meet the threshold for implementation fidelity, they had to receive a score of 4, indicating that they attended all 3 days of CompuPower Residency Experience and produced a project for the event. For this program component to be implemented with fidelity for the full sample, 75% of the industry mentors and 80% of the students needed to meet their threshold for implementation fidelity.

Parent Academy

The planned Parent Academy was not offered during either year of the evaluation. Had the Parent Academy been offered as part of the CompuPower program, the threshold for implementation fidelity for the parent or guardian of each CompuPower student would have been to attend at least six of the seven workshop sessions. For this program component to be implemented with fidelity for the full sample, the parents of more than 75% of the CompuPower students would have needed to meet implementation fidelity. To calculate implementation fidelity of this component, AIR planned to use Parent Academy attendance records.

Appendix J. Sensitivity Analysis

To check the robustness of the matching and the impact analyses, we conducted sensitivity analyses using a different set of baseline measures for the matching and thus produced different sets of analytic samples for the impact analyses. This appendix details the method and findings for sensitivity analyses. These sensitivity analyses did not find meaningfully different impact results than we estimated in the main analyses.

Propensity Score Matching and Baseline Equivalence

The research team applied the same matching method to create the CompuPower and comparison groups, but only required the two groups to share similar student-level baseline characteristics, including outcome measures at baseline and student-level demographics (see Exhibits J1 and J2 for the list of student-level baseline measures). Thus, the propensity scores were estimated using the following fixed effect logistic regression model for survey outcomes and GPA separately:

$$logit\ (T_{ij}) = \beta_0^{ps} + \beta_1^{ps}\boldsymbol{X_{ij}} + \beta_2^{ps}Grade_{ij} + \beta_3^{ps}Cohort_{ij}$$

T_{ij} is the binary variable to indicate if student *i* in school *j* participates in the program; β_0^{ps} is the overall intercept probability of participating in the program; $\boldsymbol{X_{ij}}$ is a vector of student-level baseline measures for student *i* in school *j,* including baseline self-regulation and Academic Possible Selves Survey scores, unweighted GPA at previous school year, gender, race/ethnicity, English learner status, and free/reduced lunch status; $Grade_{ij}$ and $Cohort_{ij}$ are the grade and cohort fixed effects for school *j* and used for controlling cluster effects.

Baseline equivalence was satisfied for all baseline characteristics after conducting matching for the analytic sample used in the survey outcome analysis (Exhibit J1). Baseline measures were equivalent for the GPA outcome analysis without matching, and thus all students with complete data on baseline and outcome GPA were included in the analytic sample for this outcome (Exhibit J2).

Exhibit J1. Baseline Equivalence for the Sample Used in the Social-Emotional Outcome Sensitivity Analyses

	Before matching					After matching				
	CompuPower (*N* = 62)		Comparison (*N* = 277)			CompuPower (*N* = 62)		Comparison (*N* = 186)		
Covariates	Mean	*SD*	Mean	*SD*	SMD	Mean	*SD*	Mean	*SD*	SMD
Baseline APS	2.03	2.06	2.30	2.28	-0.12	2.03	2.06	2.18	2.28	-0.07
Baseline SR	0.95	1.10	1.13	1.03	-0.17	0.95	1.10	0.99	0.89	-0.04
Previous year GPA	3.15	0.75	3.15	0.81	0.00	3.15	0.75	3.22	0.65	-0.11
Female	0.50	0.50	0.61	0.49	-0.28	0.50	0.50	0.50	0.50	0.00
Free or reduced-price lunch	0.44	0.50	0.50	0.50	-0.15	0.44	0.50	0.42	0.50	0.04
Hispanic	0.23	0.42	0.18	0.38	0.18	0.23	0.42	0.18	0.38	0.19
White	0.73	0.45	0.74	0.44	-0.06	0.73	0.45	0.74	0.44	-0.05

Note. APS = academic possible selves; SD = standard deviation; SMD = standardized mean difference, which is the baseline mean difference converted into standard deviation units using Hedges' *g* for continuous measures or Cox's Index for dichotomous measures.

Exhibit J2. Baseline Equivalence for the Sample Used in GPA Sensitivity Analysis

	Before matching				
	CompuPower (*N* = 61)		Comparison (*N* = 282)		
Covariates	Mean	*SD*	Mean	*SD*	SMD
Baseline APS	2.24	2.14	2.27	2.28	-0.01
Baseline SR	1.00	1.16	1.15	1.11	-0.14
Previous year GPA	3.06	0.79	2.98	0.93	0.09
Female	0.51	0.50	0.56	0.50	-0.13
Free or reduced-price lunch	0.39	0.49	0.42	0.49	-0.06
Hispanic	0.21	0.41	0.20	0.40	0.05
White	0.69	0.47	0.73	0.44	-0.12

Note. APS = academic possible selves; SD = standard deviation; SMD = standardized mean difference, which is the baseline mean difference converted into standard deviation units using Hedges' *g* for continuous measures or Cox's Index for dichotomous measures.

Impact Analyses

We estimated the effect of the CompuPower program on students for each outcome of interest separately by applying the same two-level random effect models indicated in Appendix G. Exhibit J3 shows the estimated effect for each outcome. Overall, the differences between CompuPower and comparison group students were not statistically significant, reflecting the results from the main analyses. The effect sizes were also similar to the effect sizes from the main analyses.

Exhibit J3. Estimated Intervention Effects on Each Outcome from the Sensitivity Analyses

	Comparison group			CompuPower Group					
Outcome measure	Sample size	Mean	*SD*	Sample size	Model-adjusted mean	*SD*	CompuPower – comparison difference	Hedges' *g*	*p* value
Adolescent Self-Regulation	186	1.00	1.06	62	1.11	1.40	0.11	0.10	0.47
Critical Thinking Skills for Everyday Life	186	1.09	0.99	62	1.25	1.34	0.16	0.15	0.28
GPA	282	3.01	0.88	61	3.13	0.64	0.12	0.14	0.21

Note. SD = standard deviation.

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