Impacts of Blended Learning Tutoring Models on Math Achievement After COVID-19: Results from Saga Education

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Executive summary

Overview of the study

We conducted an impact and implementation analysis of Saga Education's (Saga) high-dosage, online, in-person, and hybrid "blended" tutoring models in three school districts across the United States during the 2021–2022 school year, when schools were still struggling with the COVID-19 pandemic and its repercussions for student learning. We use a matched comparison design to compare students who participated in Saga with similar students within their school districts and a descriptive analysis to understand facilitators and barriers to program implementation and effectiveness.

Key findings

- Saga had a large, positive impact on student algebra standardized test scores in one district and on geometry standardized test scores in another but no effects on two other standardized tests. Saga also had positive effects on student math grades across districts and models.
- The impacts of the online blended tutoring model were larger than the impacts of the in-person blended tutoring model, and the impacts of the hybrid blended model were in-between. This may be due to the online model having smaller tutoring groups and fewer staffing challenges, but it could also be due to other implementation or contextual factors.
- The impacts of Saga on math performance were largest for students in schools with smaller tutoring groups (of two students or fewer) and fewer challenges with hiring and retaining enough staff. Saga also had the largest impacts on students with lower prior achievement in math and Black students.
- Saga had a small, negative impact on school attendance and some Saga staff reported challenges with maintaining student engagement.

Recommendations and conclusions

Online tutoring models have promise, especially when it is challenging to hire in-person tutors. This study found that Saga's online blended model increased student performance on some outcomes, and that it was easier to hire for remote tutoring roles than in-person tutoring roles in 2021-2022 (leading to smaller group sizes in the online model). Because this study was not designed to rigorously compare the effectiveness of different models, future studies should examine whether online tutoring models may be similarly effective to in-person tutoring models.

More research is needed to understand whether smaller group sizes may drive larger impacts for tutoring programs. This study found an association between tutoring group sizes and impacts, but we could not determine whether group sizes or implementation challenges and understaffing drove those differences.

Students may benefit the most from intensive tutoring if they have lower prior achievement in that subject area. This study found larger impacts for students with lower prior achievement in mathematics and in schools and student populations where program participation was geared more toward lower-performing students. Because this pattern could be driven by other unobservable student or school characteristics associated with prior achievement, future studies should examine this relationship further.

Technology-driven tutoring programs should find ways to improve student engagement. This study indicates that blended models show promise for improving student outcomes, but these models can create additional challenges for student engagement and attendance. Tutoring programs and online learning platforms should continue to improve on students' experience using these tools.

Introduction

Tutoring programs could be an effective way to mitigate learning losses from the COVID-19 pandemic. The pandemic negatively affected student learning across the country, and it particularly affected students who are Black, Latino, or experiencing poverty (Kuhfeld et al., 2022). The federal government gave states billions of dollars to try to help students recover academically from the pandemic, and many states have been using the funds on tutoring (Council of Chief State School Officers, 2023). Research has shown that high-dosage tutoring, often defined as individual or small-group tutoring at least three times per week, is a highly effective strategy for supporting student learning (Sawchuk, 2020). A recent meta-analysis of 96 studies found that the average tutoring program had substantial positive effects on student learning outcomes and that math tutoring programs can be particularly effective (Nickow et al., 2020).

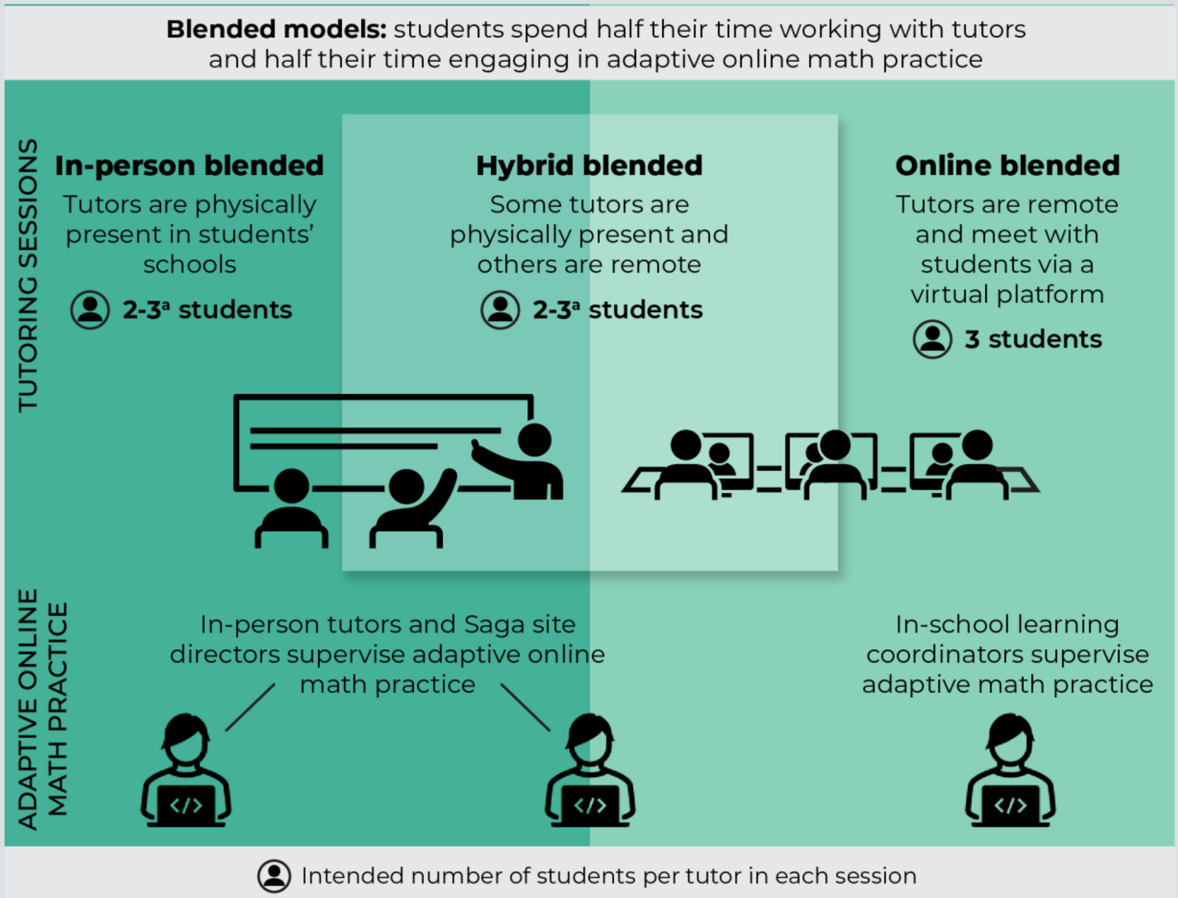
Saga Education's math tutoring model has been shown to be a particularly promising approach to improving student math outcomes. Saga uses an evidence-based model that employs trained tutors to work with 9th- and 10th-grade students during the school day. Because Saga's tutors receive only a modest stipend that is subsidized by AmeriCorps, the Saga program costs districts a fraction of what most tutoring programs cost (Guryan et al., 2023). Previous impact evaluations of Saga's "traditional model" of program delivery, in which small groups of two students work with a tutor each day, have shown that Saga positively impacts a variety of student outcomes, including math test scores, math course grades, and math course pass rates, and grades in other subjects. Impact estimates on math standardized tests range from 0.18 to 0.40 standard deviations, which are considered moderate or large (Guryan et al., 2023; Kraft, 2020). Additional details on Saga are included in Appendix A.

Building on these promising findings from this "traditional model," Saga began offering "blended learning" models that rely on digital tools and platforms to serve more students, increase student-tutor ratios, and thus provide more affordable and accessible programming to districts (see Box 1). Students enrolled in Saga's in-person, online, and hybrid blended models spend approximately half of their dedicated tutoring time working with their tutor in small groups, and the other half engaging in adaptive online math practice that automatically adjusts to students' learning levels to continually build their skills and knowledge. There is limited evidence on the effectiveness of these three lower-cost models.

To better understand the effectiveness of Saga's three blended learning models, we conducted an independent quasi-experimental evaluation of Saga to learn about the implementation and impacts of its online blended learning model. This evaluation is focused in particular on students who are Black, Latino, and/or experiencing poverty.

We acknowledge that this study reflects the challenges of implementing a tutoring program during the COVID-19 pandemic. The pandemic caused substantial and widespread challenges for public education, and Saga's programming is no exception. Our findings reflect some important COVID-19 related implementation challenges that likely affected the impacts that Saga was able to achieve, including attendance, tutor staffing levels, and the availability of in-school support staff (both Saga and district staff). On the other hand, the pandemic accelerated a longer-term shift to technology-assisted and technology-facilitated educational services that is likely to continue. We hope that this study can contribute to guiding and informing how technology-assisted tutoring can be leveraged to best meet the learning needs of the populations served by Saga.

Box 1. Snapshot of the Saga models included in this study



a The number of students in tutoring sessions excludes the two or three students using the online adaptive math practice that tutors also partially supervise during their tutoring sessions in the in-person and hybrid blended models. However, Saga reported that most site directors placed all students who were engaging in the online adaptive math practice in one part of the room so that the site directors could mostly supervise these students instead of the tutors.

Terminology note: Saga refers to tutoring by remote staff and the online blended model as "live-online." In this report we refer to this model as the "online" model, and these tutors as "remote" for conciseness and to help differentiate between the online and hybrid models, which both offer live-online tutoring.

Road map to the report

In the next section, we provide a brief overview of the study, including the schools and students included in our sample, the methods and data sources used, and the main limitations of the study. We then summarize the results of our study focused on key findings from across the three models and districts included in the study. We conclude with a summary of findings and potential recommendations for future implementation of Saga and other high-dosage tutoring programs. Additional information about the context of the study, the data collection and analysis methods used, and detailed findings are provided in the appendices.

Overview of the evaluation

Who participated in the study?

2,129 Saga students from three large, urban districts in the midwestern and southeastern United States participated in the study in the 2021–22 school year. Table 1 summarizes the relevant Saga models used in each district and samples for each.

Table 1. Number of students in the study

	Study district			
Saga model	A	B	C	Total
In-person	—	—	949 (14)	949 (14)
Hybrid	—	243 (1)	274 (3)	517 (4)
Online	554 (6)	83 (2)	—	637 (8)
Saga students	560	329	1,240	2,129
Comparison	11,029	1,163	12,831	25,023

Note: The numbers in parentheses represent the number of schools implementing each model.

How was the study conducted?

Our impact evaluation had three main steps. Please see Appendix C for additional details.

1. **School-level matching.** We selected a set of comparison schools that had similar achievement on standardized tests and demographic characteristics to the Saga schools.
2. **Student-level matching.** We used statistical matching methods to create a comparison group of students who did not participate in Saga (across Saga and comparison schools) that matched the Saga students on baseline math achievement and student characteristics.
3. **Impact analysis.** We then conducted regression analysis that incorporated both student-level propensity score weights and controls for student-level characteristics and baseline achievement. We calculated both overall district impacts and school-specific impacts. Then we combined overall and subgroup impacts across districts using meta-analytic methods.

For the implementation analysis, we applied descriptive quantitative techniques to Saga program data and a web survey of school leaders in Saga and comparison schools. We also conducted a thematic analysis of qualitative data from interviews with Saga site directors. Please see Appendix A for findings from Saga program data, and Appendix B for findings from the web survey.

What outcomes were measured?

The study focused on **standardized test scores in mathematics**. This included PSAT math scores (in District C), an algebra end-of-course (EOC) exam (in Districts A and B) and a geometry EOC exam (in District A). We also examined impacts on other outcomes, including **student math grades**, **GPA**, and **attendance**. We also examined whether different **implementation factors** were associated with student outcomes, including attendance in Saga sessions, student-tutor ratios, and total tutoring time.

What data were used?

- **Saga program data** on student enrollment, attendance, staffing, and staff satisfaction
- **School-level data** from district websites and the Common Core of Data from the National Center for Education Statistics
- **Student-level data** from districts on student demographic characteristics, school attendance, course grades, and standardized assessment scores
- **Survey data** from a subset of principals and other designated staff at Saga and comparison schools
- **Interview data** with Saga site directors with a subset of Saga site directors

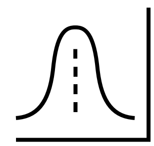
What are the limitations of the study?

We used matching methods to select a sample of non-Saga, or "comparison," students who were as similar as possible to Saga students in terms of their prior achievement and demographic characteristics and used this sample to model what Saga students' outcomes would have been without participating in tutoring. If Saga students are different from non-Saga students on unobserved characteristics (such as confidence in math), that could bias our findings. Additionally, models were not randomized across schools, so any differences in impacts between the online, hybrid, and in-person blended models could be due to school- or district-specific factors, and not to differences in the models themselves.

Secondly, our study was conducted during the COVID-19 pandemic and its aftermath, which affected tutor staffing levels, students' standardized test-taking, student learning and attendance, and more. The results likely differ from those that we would have observed without the pandemic.

Key terms

- **Saga school.** A school that agreed to participate in Saga and offer Saga tutoring sessions for selected students.
- **Saga student.** A student in a Saga school who was assigned to participate in Saga tutoring within the first three weeks of the school year and attended at least one tutoring session.
- **Comparison student.** A student who was not selected to participate in Saga tutoring. This student may have attended a Saga school or a comparison school.
- **Standard deviations.** A unit of measure that translates student outcomes from different districts and outcomes into a consistent unit based on group averages and how much the outcomes vary. This allows us to present "apples-to-apples" comparisons between the different districts and outcomes in the study. In education research, positive effects between 0 and 0.05 standard deviations are typically considered small, from 0.05 to 0.20 are considered moderate, and 0.20 and above are considered large (Kraft, 2020).



- **Remote tutor:** A tutor who was not physically located in a school, and who connected with their students via an online platform. These tutors may have served schools offering either the online or the hybrid model.
- **In-person tutor:** A tutor who was physically present in a school. These tutors may have served schools offering either the in-person or the hybrid model.

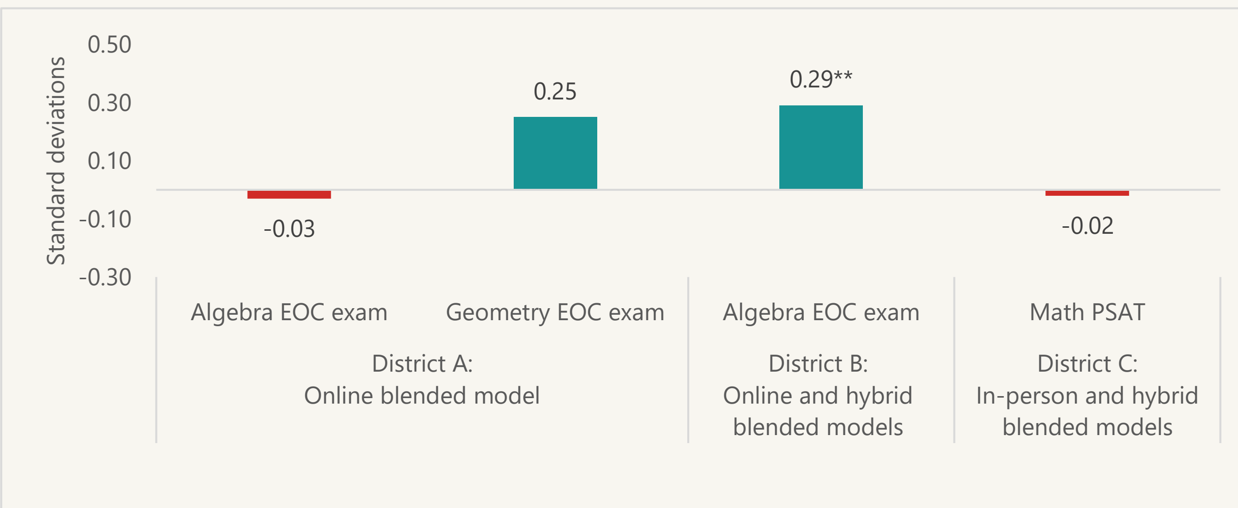
Key findings

Saga's online and hybrid blended learning models improved student performance on some math exams, compared to no impact for Saga's in-person blended learning model.

Saga had a positive impact on math end-of-course exams in one school district, mixed results in a second district, and no impact on students' PSAT scores in a third district.

Saga significantly improved students' performance on algebra EOC examinations by 0.29 standard deviations in District B and increased student pass rates on the exam by 15 percentage points (Figure 1). In District A, Saga had no impact on algebra EOC examinations but increased average geometry EOC scores by 0.25 standard deviations as well as the number of students who scored "satisfactory" or above on the geometry EOC exam by 11 percentage points. Although the impact on geometry EOC examination scores was not statistically significant due to a small sample of Saga students, a Bayesian analysis indicated that there is a 97 percent chance that Saga improved students' geometry performance. Saga also had no impact on the math PSAT in District C. The variation in impacts on standardized test scores across districts and exams may have been driven by multiple factors, including the Saga blended learning model used; variation in implementation of the model; and district-specific factors, such as the response to COVID-19. This study was not designed to rigorously assess differences in impacts across models or other factors, but we explore some of these potential explanations below.

Figure 1. Impact of Saga on student standardized test scores, by school district



Source: District administrative data.

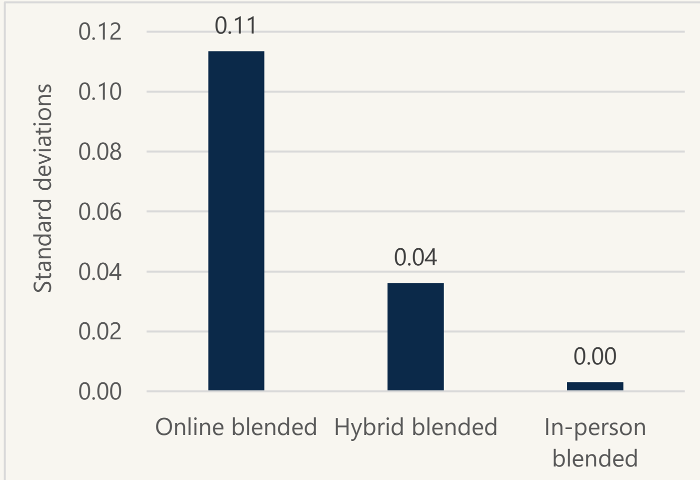
Note: For sample sizes, please see Appendix D.

**Significantly different from zero at the .01 level, two-tailed test.

The impact of Saga's online blended model was larger than the impacts of Saga's in-person blended model, although these larger impacts could be explained by many factors other than differences in the effectiveness of the models.

Saga's online blended model improved student test scores by 0.11 standard deviations, which is larger than the impacts on the hybrid blended model (0.04 standard deviations) and the in-person blended model (0.00 standard deviations) (Figure 2). The online blended model had more positive effects than the hybrid model despite students in online tutoring groups receiving up to 10 fewer hours of tutoring, on average, over the course of the year. The difference in impacts between the online blended model and in-person blended model may be explained by the differences in staffing challenges and group sizes, as discussed in more detail below.

Figure 2. Estimated impacts, by type of blended model



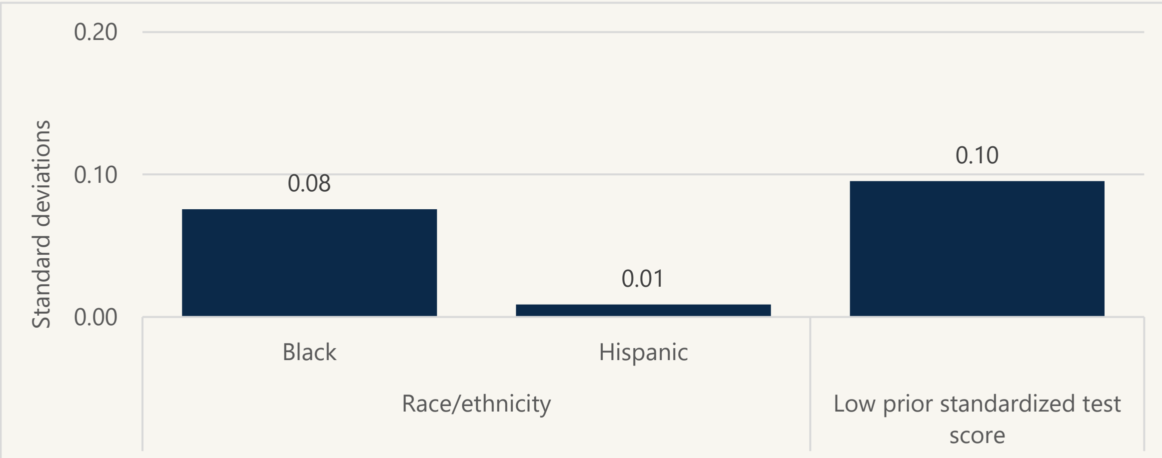
Note: These estimates were computed from average impacts across the 26 schools included in the study. Although they differ somewhat from those computed at the student level, the overall pattern of findings is consistent with those presented elsewhere.

Saga had larger impacts on students with lower prior math achievement and Black students, relative to other students.

Students with lower baseline standardized test scores experienced larger impacts on standardized test scores (Figure 3). In District C, students with below-median baseline math achievement experienced positive and statistically significant impacts on the PSAT; this translates into an improvement from the 11th to approximately the 14th percentile overall. Additionally, Black students also experienced above-average benefits across districts, whereas Hispanic students experienced benefits that were more similar to the overall population of Saga students. More than 80 percent of Saga students across all three districts were Black and/or Hispanic. There were no clear patterns in differential impacts by student grade or gender.

Similarly, schools and districts that selected lower-performing students for Saga experienced the largest impacts. In District B, where we observed the largest impacts, no students had taken honors classes before and only 4 percent of Saga students had prior math test scores above the state average. In contrast,19 percent of Saga students in District C and 13 percent of students in District A had standardized test scores above state or district averages, and one in three Saga students in District A had taken an honors math class in the previous two years. It is possible that tutoring may not be as beneficial for higher-achieving students or that tutors had more difficulties tailoring content when students of different levels were grouped together (as some Saga staff reported). There were no other clear associations between school-level impacts of Saga on standardized tests and other contextual and student population characteristics, suggesting that student background and implementation characteristics may be more predictive of tutoring impacts than school-level factors.

Figure 3. Effect on standardized test scores, by student demographics and prior standardized test scores



Source: District administrative data.

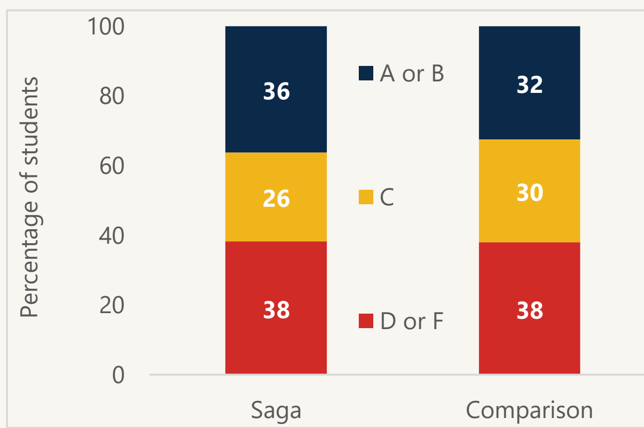
Note: Findings reflect meta-analytic effect sizes across all districts. Due to a lack of baseline equivalence for some subgroups, findings for Hispanic students reflect only District A and District C students, and results for students with low standardized test scores and non-Black, non-Hispanic students are not available because this subgroup was only equivalent at baseline in District B, and samples were very small. Please see Appendix D for sample size information.

Saga blended learning models improved student math grades across models.

Saga had a small but positive overall effect on student math grades across models

Across districts, Saga students were 4 percentage points more likely to receive an A or B and less likely to receive a C (Figure 4). This improvement in student math grades did not translate into more students passing their math class (math failure rates were similar across groups) or an improved overall GPA (both Saga and comparison students had an average GPA of 2.2).

Figure 4. Student math letter grades, by Saga status



Source: District administrative data.

Note: The results are weighted, regression-adjusted averages aggregated across districts. Sample sizes: 2,079 Saga, 24,615 comparison.

Similar to our findings on standardized test scores, Saga's effects on student grades were concentrated among students with lower prior performance in their math classes. Students with a math grade of D or below during the previous school year experienced larger impacts on their math grades than students who had previously received a C or above. Saga students who had previously received Fs received nearly twice as many A's in math as their comparison counterparts. In District C, the effects on math grades were more than three times as large for students who previously received a D or below in their math class (0.16 compared to 0.05 points on a 0 to 4 GPA scale).

Due to challenges in hiring in-person tutors, group sizes were substantially larger at in-person sites. Impacts were largest in sites with the fewest staffing challenges and smallest group sizes.

Recruiting and retaining tutors for in-person roles became substantially more challenging than for online roles during the 2021–2022 school year, leading to larger group sizes for in-person blended models.

Saga was only able to recruit approximately 60 percent of their target number of tutors in the in-person sites in District C, whereas Saga was able to recruit 100 percent of their target number of tutors in online sites in District A and District B. Recruitment for remote tutors may have been easier both because many tutors preferred working from home and because Saga could draw tutors from a larger geographic range if they did not need to work at the school site. Because of the challenges recruiting tutors for in-person roles, Saga changed some in-person sites to hybrid sites, in which some tutors were remote and others were in person.

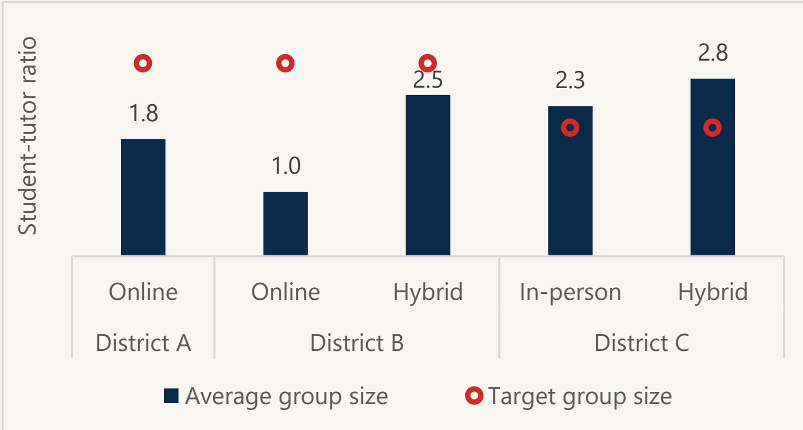
Remote tutors also had lower turnover than in-person tutors, which provided more stability for student-tutor relationships in the online blended model. The median tenure of an in-person tutor was 63 percent of the weeks in the academic year, compared to virtually no turnover for remote tutors. This may have been related to remote tutors being more satisfied in their positions. Remote tutors reported a satisfaction level of 8.5 out of 10, compared to 7.0 for hybrid tutors and 7.3 for in-person tutors. Additionally, hiring remote tutors may have allowed Saga to identify staff who were more similar demographically to Saga students and with more applicable skills. For example, school staff reported and Saga internal data indicate that remote Saga tutors may have been more racially and ethnically diverse than in-person tutors. In addition, one site director at an online site reported that two of their remote tutors spoke Spanish, which benefited some English learners.

Due to staffing challenges with the in-person blended model, the student-tutor ratios were larger than intended in the in-person blended model. Additionally, due to student under-enrollment in the online blended model, the student-tutor ratios were smaller than intended in the online blended model. Tutors in the in-person blended model worked with an average of 2.3 students, whereas tutors in the online blended model worked with an average of 1 to 1.8 students (in District B and District A, respectively) (Figure 5). Ratios at the school level ranged from approximately one student per tutor per session (in the online blended model) to more than three students per tutor per session (in the in-person blended model). Some in-person tutors also had the added responsibility of checking in on students engaged in adaptive online math practice. Saga staff report that understaffing had important ramifications in terms of tutor management and coaching, tutor-student relationships, guardian communication, and tutor turnover and satisfaction levels. Saga's on-site staff also struggled to juggle coaching and mentoring tutors with the additional classroom management responsibilities caused by understaffing.

Adapting lessons or behavior management is harder when you have five or six students rather than three or four students in a period. And then things like parent calls—making 30 calls instead of 24—is a larger effort. During [tutoring] it's tougher to go back and forth between three students compared to two.

Saga site director

Figure 5. Student-tutor ratios compared to original targets, by district and model



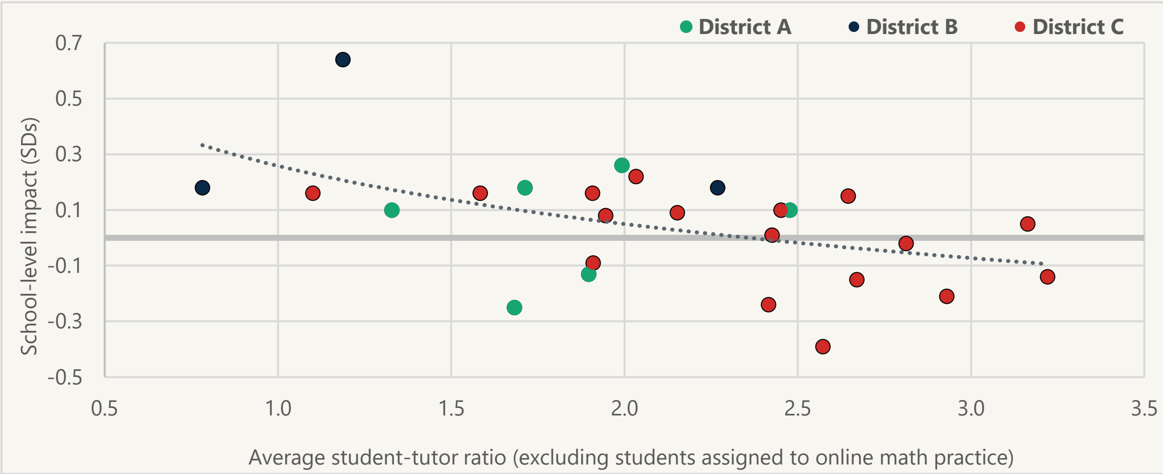
Source: Saga program data.

Note: Student-tutor ratios reflect the average number of students assigned to a tutor during a session over the academic year. Prior to averaging, group sizes were divided in two to exclude students engaged in adaptive online math practice and top-coded at the 99th percentiles to limit the influence of temporary fluctuations in group sizes.

Saga had a larger impact on standardized test achievement in schools with smaller group sizes and fewer staffing issues, but more research is needed to understand this relationship.

We find that schools in which tutors worked with students one-on-one (and had no staffing issues) had larger average impacts (above 0.2 standard deviations), and schools in which tutors worked with students in groups of two (and also had fewer staffing issues) had small impacts (0.06 standard deviations) (Figure 6). The schools with larger groups and more substantial staffing issues had impacts that were slightly negative (–0.07 standard deviations). Because these differences in group sizes were not planned, but instead were the result of staffing shortages, we cannot differentiate between the differences in impacts being due to group sizes versus staffing or other implementation issues. Additionally, some of the differences in impacts may be due more to district-level factors, since the smallest group sizes were concentrated in the district with larger impacts (District B) and the largest group sizes were concentrated in the district with smaller impacts (District C). We believe more research is needed to understand the relationships between group sizes and program impacts specifically in the context of blended learning models.

Figure 6. Association between average student-tutor ratio and school-level impacts of Saga



Source: District administrative and Saga program data.

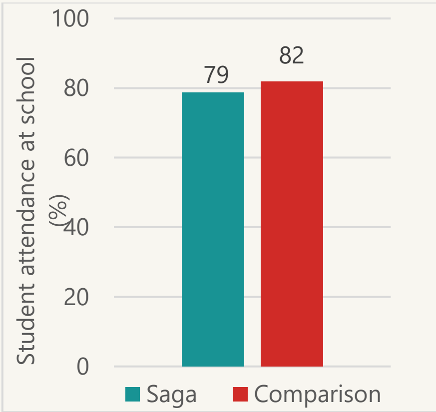
Note: Impacts for District A are the combined algebra and geometry EOC exam scores. The results represent 1,712 Saga students from the 26 Saga schools in our sample.

Saga students tended to have lower overall attendance than comparison students, especially in schools with larger group sizes.

School attendance rates for Saga students were 3 percentage points lower than comparison students' (79 percent, compared to 82 percent). The difference in school attendance rates translates into a little more than five days for a standard 180-day school year. These effects tended to be larger in schools with fewer staff and larger student-tutor ratios. Focusing only on Saga sessions, we find that Saga students in the in-person blended model attended 71 percent of sessions, compared to 76 percent of sessions for the online and blended models (Figure 7). It is possible that Saga students in the in-person blended models were less motivated to attend Saga sessions if their group sizes were larger or if there were more implementation challenges in those sessions. Some Saga site directors also noted that some students would skip Saga adaptive online math practice sessions because they did not find them to be as engaging as the tutoring sessions, but unfortunately, our attendance data does not allow us to examine attendance by tutoring sessions versus adaptive online math practice sessions. Site directors reported using a variety of strategies to increase attendance, including conducting contests with incentives tied to attendance, contacting students' guardians, coordinating with other teachers, and leveraging a personal relationship with a student where possible. However, it was more challenging for staff to reach out to individual families when they had larger caseloads due to staffing issues.

Figure 7. Student attendance

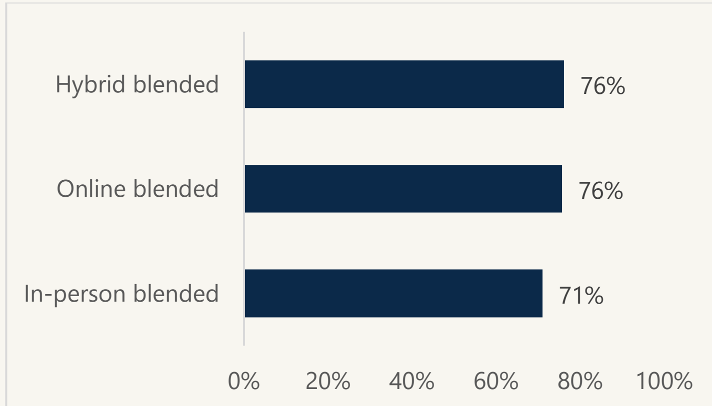
Panel A. School attendance, by Saga status



Source: District administrative data.

Note: The results are weighted, regression-adjusted averages aggregated across districts. Sample sizes: 2,129 Saga and 25,023 comparison.

Panel B. Student attendance of Saga tutoring and adaptive online math practice sessions, by model



Source: Saga program data.

Note: These results reflect 2,923 Saga students who met the criteria for inclusion in our impact evaluation sample. Differences in sample sizes from the impact analysis reflect missing data in our analysis variables.

Although blended learning models have promise relative to traditional tutoring models, tutoring programs can continue to improve and refine these models.

Site directors reported that lesson pacing and student engagement were more challenging in the blended models relative to the traditional model (in which students only meet with tutors and do not use adaptive online math practice tools). First, lesson pacing was more challenging because tutors can only cover new content every other day (compared to every day in the traditional model), meaning sometimes it was hard for tutors to keep up with the pace in students' math classes. Second, Saga staff reported that students would sometimes struggle to focus during the adaptive online math practice and that they needed to use creative strategies to increase engagement during those sessions.

> *Students don't inherently enjoy [adaptive online math practice].... they are craving human interaction so when you place them in front of a computer screen, it's a challenge."*
>
> Saga site director

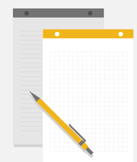
Saga staff also found ways to mitigate these issues. They met regularly with school math department staff to increase curriculum alignment between students' math classes and Saga's curriculum, and they read briefings provided by the math departments on upcoming content to cover. Saga staff also reported that the adaptive online math practice was an effective way for students to focus on foundational skills in addition to the new content being introduced in the math curriculum and that students enjoyed some of the video game-like platform features of the adaptive online math practice tools. Saga and other tutoring programs may need to continue to consider additional ways to support students in blended models to ensure the curriculum is moving at the right pace and that students remain engaged in tutoring.

Conclusions and recommendations

During the 2021–2022 academic year, Saga's impacts varied substantially based on observed implementation characteristics, including model, group size, and student prior achievement levels. Our pattern of findings suggests the following broad conclusions and recommendations.

Online tutoring models have promise, especially when it is challenging to hire in-person tutors. This study shows that remote tutoring can increase student performance, and may be a promising option when there are challenges in hiring enough tutors for in-person roles. Using remote tutors can make it easier to hire enough tutors and keep tutoring group sizes smaller. In this study, remote tutors reported more satisfaction with their jobs and had lower turnover than in-person tutors, which could benefit students in terms of the quality of tutoring and the strength of their relationship with their tutors. Tutors may have had a stronger preference for remote roles during the school year in which this study took place (when COVID-19 was still having a major impact on schools), but some of these tutor preferences will likely continue into future years.

Considerations for future research



The strongest approach to understanding the possible relationships between tutoring models, group sizes, and program impacts would be to conduct a multi-armed randomized controlled trial. For example, a study could randomly assign schools to provide in-person or online tutoring, and randomly assign tutors to work with groups of different sizes. If this is not feasible, future studies could also consider "rapid-cycle" evaluations that can quickly generate actionable learnings by comparing the results of different intervention approaches using rapid assessments and other short-term outcomes.

More research is needed to understand whether smaller group sizes may lead to larger impacts for tutoring programs. This study found an association between tutoring group sizes and impacts, but because many of the larger group sizes were driven by issues with understaffing, we could not determine whether it was the group sizes themselves or the implementation challenges leading to larger group sizes driving this relationship. Prior research on group sizes and tutoring is somewhat mixed, but there may be a relationship between tutoring group sizes and impacts (Nickow et al., 2020). The impacts of group sizes on student outcomes are particularly hard to study since tutoring group sizes often shift over the course of tutoring programs, but future work in this area would be important to better understand the relationship between group sizes and tutoring impacts.

Students may benefit more from intensive tutoring if they have lower prior achievement in that subject area, but more research is needed to understand this relationship further. This study found larger impacts for students with lower prior achievement in mathematics and in schools and student populations where program participation was geared more toward lower-performing students. Saga and other similar tutoring organizations could consider if lower performing students may benefit the most from tutoring in their schools and be intentional about prioritizing students that could benefit the most from tutoring. Some prior studies have also shown that tutoring might be the most effective for lower-performing students, although other studies have found that tutoring benefits students at all levels of prior performance (Kraft and Falken 2021).

Technology-driven tutoring programs should continue to identify ways to improve student engagement. The study indicates that blended models show promise for improving student outcomes at lower costs, yet these models can create additional challenges for student engagement. Saga staff interviewed for this study reported that students may have struggled more with staying focused during adaptive online math practice sessions than tutoring sessions and that students may have been more likely to skip the adaptive online math practice sessions. Tutoring programs should consider new ways to overcome these difficulties, potentially through more in-school staff; deep collaboration between tutoring programs and school staff; student incentive programs; and more engaging, user-friendly, and "gamified" online platforms. Saga is experimenting with a variety of approaches, including data-driven improvements to tutoring approaches and online adaptive practice tools, and "low-tech," hands-on math activities that can support math intuition and reasoning (Saga Education 2022).

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Appendix A. Additional details about Saga tutoring

Program description

Saga Education provides an intensive math tutoring program for students in grades 9 and 10 who are mostly Black, Latino, and/or experiencing poverty (which characterizes 90 percent or more of our study sample). Founded in 2014, Saga uses an evidence-based model that employs trained service fellows to tutor high school students during the school day (for example, see Nickow et al. [2020] for evidence on tutoring and Guryan et al. [2021] for specific evidence on the effectiveness of Saga). Schools select students who they believe would benefit most from tutoring to participate in Saga. Tutoring lessons are then personalized for students' individual needs and delivered by trained service tutors, who commit to a minimum of one year of service to Saga. The goal is for each tutor to remain with the same students for the duration of the school year in order to build strong relationships and knowledge of students' needs and strengths. Saga's curriculum focuses on culturally relevant lessons in which students engage in "productive struggle" to master math concepts. Saga site directors meet weekly with Saga students' math teachers to ensure that lessons are aligned with students' math work, and tutors reach out monthly to families to discuss students' progress and challenges. Saga tutors report to a site director, and site directors report to a director of programs. Saga currently operates in four school districts across the United States, and this study focuses on Saga's implementation and impacts in three school districts.

Box 1 in the main report provides a summary of the three models in this study: the in-person blended model, the online blended model, and the hybrid blended model. The online and hybrid blended models are the most recently developed models, and they use the Saga Connect online platform to connect remote tutors with students. The platform uses a number of features to engage students and facilitate collaboration, including screen sharing between the tutor and students and between students working with the same tutor; chat features; freehand drawing; and digital manipulatives, such as dice and geometric shapes. Schools dedicate space to serve as a Saga tutoring classroom where Saga students, monitored by a Saga site director, either work with their tutors online through Saga Connect or engage in independent math practice using adaptive math software with technical support and supervision by a Saga learning coordinator.

Tutoring dosage and attendance

Previous research defines high-dosage tutoring as occurring three days a week or more, or at least 50 hours over the course of a semester (Fryer, 2017). Saga's tutoring program aimed to exceed this threshold of 50 hours a semester, while aligning with the academic calendars in each school district. Saga's intended tutoring dosage was an average of 138 hours a year across District A, District B, and District C, meaning that students would receive tutoring almost every day of the school year (Table A.1).

Largely due to attendance challenges (both attendance of Saga students at school in general as well as specifically for tutoring sessions), Saga students received an average of 81 hours of tutoring and adaptive online math practice, or 59 percent of the intended dosage, in study districts (Table A.1). Despite attendance challenges, Saga's internal program data indicates that students in District C received similar levels of tutoring in the 2021–2022 school year as they received in the 2020–2021 school year (85–87 hours in 2021–2022 compared to 89 hours in 2020–2021); students in District A received higher dosages of tutoring in 2021–2022 than the previous year (78 hours compared to 57 hours in 2020–2021). We are unable to report dosage and attendance separately for adaptive online math practice and tutoring due to data quality issues and block scheduling in some schools, which meant that students spent half of the same class period on each mode of instruction.

On average, Saga students attended 74 percent of sessions. Attendance rates were highest in the online and hybrid models compared to the in-person blended models, but these differences were relatively small. Students in District C received higher dosages of tutoring than students in District A and District B; even though attendance was lower, class schedules meant that Saga was able to offer District C students more hours of tutoring.

Table A.1. Saga dosage and attendance, by district, model, and grade

District	Model	Intended dosage (hours)	Offered dosage (hours)	Dosage received (hours)	Percent of intended dosage received	Average Saga attendance rate (percent)
District A	Online blended	132	106	78	59	76
District B	Online blended	138	74	55	40	74
	Hybrid blended	122	98	76	62	79
District C	In-person blended	144	121	85	59	71
	Hybrid blended	141	120	87	62	74
Average		138	113	81	59	74

Source: Saga administrative data.

Note: Attendance is calculated as the number of sessions that a student attended, out of the number of sessions that Saga offered while the student was enrolled in the program.

Appendix B. Additional details about the study schools

Overview

This appendix summarizes the results of a survey administered to principals and school administrators across Saga and comparison schools on typical math instruction, math curricula, and student tutoring supports. We present these findings to help contextualize the impacts of Saga in the study districts and explore any potential differences in math resources between Saga and comparison schools that could influence the study findings. We find that Saga and comparison schools provided similar math instruction and relatively similar curricula to comparison schools, although Saga schools were more likely to use math instructional materials (like Khan Academy) than comparison schools. Additionally, both Saga and non-Saga schools offered less-intensive math tutoring supports, and about one-quarter of District C comparison schools offered intensive "Saga-like" math tutoring.

Despite some small differences between Saga and comparison schools, we do not believe any are widespread enough to significantly bias the impact of Saga found in the impact evaluation and make Saga appear either more or less effective than it actually was in the study districts during the 2021–2022 school year. This is both because most of the comparison sample comes from Saga schools (not comparison schools) and because the differences between Saga and comparison schools are relatively small. These responses also only reflect the 65 percent of principals and school administrators who responded to the survey and thus does not reflect the math context of all the schools in the study.

Math instruction

Class sizes and hours of math instruction per week were similar across Saga and comparison schools in the same districts (Table B.1). All districts had class sizes of 25 to 26 students. District A and District C schools reported approximately four hours of math instruction per week, whereas District B offered approximately six hours per week.

Table B.1. Characteristics of math and school programs

	District A		District B		District C	
	Saga	**Comparison**	**Saga**	**Comparison**	**Saga**	**Comparison**
Average number of students in a math class	26	26	25	n.a.	25	25
Hours of math instructions per week	3.4	3.8	6.3	n.a.	3.9	4.1
Responses	4	3	3	1	13	11
Response rate	66%	50%	100%	33%	76%	58%

Source: Saga evaluation principal survey.

Note: Survey responses for class size were reported as a range rather than a single number (such as 25–30 rather than 25). We calculated the class size for each district group by determining the midpoint of the range provided (such as 27.5 for a response of 25–30) and averaging the midpoints across schools. Because we only received one response from District B comparison schools, these results are not reflected in the table as there is a risk of re-identification.

n.a. = not applicable.

Math curricula and instructional materials

Across districts, most schools reported using multiple math curricula, but there were a few differences in the relative popularity of different kinds of curricula in Saga versus comparison schools (Table B.2). The most commonly reported curricula across Saga and comparison schools were teacher-, school-, or district-created. The most common published curricula included Pearson Traditional and Glencoe Traditional, which either do not or only partially meet expectations according to EdReports, an independent nonprofit that reviews K–12 instructional materials for alignment to college and career-ready standards. Especially in District C, Saga schools were more likely to use school- or district-created curricula (which may vary in quality) than comparison schools, which were slightly more likely to use published curricula like SpringBoard Traditional that did not meet EdReports' expectations. Table B.2 provides the frequency of the curricula reported by schools along with the EdReports rating.

Table B.2. Math curricula used in Saga and comparison schools

Curriculum	Percent of Saga schools reporting use	Percent of comparison schools reporting use	Percent difference between use in Saga schools and comparison schools	Curriculum quality rating from EdReports
Teacher-created	81	79	2	n.a.
School- or district-created	81	57	24	n.a.
Pearson Traditional	24	43	–19	Does not meet expectations
Glencoe Traditional (McGraw-Hill Education)	33	29	4	Partially meets expectations
Holt McDougal Larson	24	14	10	Does not meet expectations
SpringBoard Traditional	5	21	–16	Does not meet expectations
Illustrative Mathematics	24	14	10	Meets expectations
Algebra Nation	24	29	–5	NA
Carnegie Integrated	10	0	10	Partially meets expectations

Source: Saga evaluation principal survey and https://www.edreports.org/reports

Note: This table includes the 35 schools that responded to the principal survey (including 24 schools from District C, seven schools from District A, and four schools from District B. The survey question was: "What curricula do math classes for students in 9th and 10th grades use?"

n.a. = not applicable; NA = not available.

In addition to curricula, school staff also reported on additional instructional materials that are regularly used in math classes for students in 9th and 10th grades, either during class or outside class. Saga schools in District A, District B, and District C tended to use a greater variety of additional instructional materials in math instruction (average of 4.6 tools across districts) than comparison schools in their respective districts (3.4 tools). The most frequently used tools by both comparison and Saga schools were Khan Academy (which was also the adaptive online math practice tool in District A) and Kahoot. Table B.3 summarizes the most frequently reported tools.

Table B.3. Math instructional materials used in Saga and comparison schools

Instructional material	Percent of Saga schools reporting use	Percent of comparison schools reporting use	Percent difference between use in Saga schools and comparison schools
Khan Academy	90	71	19
Kahoot!	76	64	12
Desmos	43	50	–7
Quizizz	48	36	12
IXL Math	48	36	12
YouTube	38	14	24
Quizlet	33	7	26
ALEKS	14	21	–7
Delta Math	19	14	5
BrainPOP	24	0	24
MATHia	5	0	5
Mathspace	5	0	5

Source: Survey administered to school staff.

Note: This table includes the 35 schools that responded to the principal survey (including 24 schools from District C, seven schools from District A, and four schools from District B. The survey question was: "Beyond curricula, please indicate which additional instructional materials are regularly used (once a week or more, on average) in the math classes for students in 9th and 10th grades. These materials can be used during class time or outside designated class time (such as homework)."

Tutoring programs

Most Saga and comparison schools responded that some non-Saga math tutoring was offered to 9th- or 10th-grade students, although most of this tutoring was less intensive than Saga (Table B.4). In District C, fewer schools reported offering tutoring programs other than Saga, but the tutoring that was provided tended to be more intensive. Eight percent of Saga schools and 27 percent of comparison schools in District C offered "Saga-like programming" to students; we define this as math-focused tutoring programs delivered to small groups or individuals by a math teacher or dedicated math tutor and for which students are selected based on grades or a teacher recommendation. Most of these programs served less than 25 percent of students in the school and were voluntary for students.

Despite the availability of these Saga-like programs for some comparison students in District C, it is unlikely that they diluted the impacts in District C relative to those we would have found if comparing Saga to no tutoring. Because we matched students within and across schools and incorporated school-level factors into weighting, the majority of comparison students were enrolled in Saga schools where Saga-like tutoring programs were less common. Thus, it is unlikely that a large proportion of comparison students received Saga-like tutoring. Given the small number of comparison students likely to have been affected by Saga-like tutoring, any implications for the effect of Saga tutoring would likely have been very small.

Table B.4. Availability of math tutoring in Saga and comparison schools, by district

District	Saga	Comparison	Difference
All non-Saga math tutoring (percent of schools)			
District A	100	100	0
District B	100	100	0
District C	54	100	–46
Average	70	100	–30
Intensive non-Saga math tutoring (percent of schools)			
District A	0	0	0
District B	0	0	0
District C	8	27	–19
Average	5	20	–15

Source: Saga evaluation principal survey.

Note: This table includes the 35 schools that responded to the principal survey (including 24 schools from District C, seven schools from District A, and four schools from District B).

Appendix C. Additional information about how the study was conducted

Impact evaluation

We conducted a two-phase matching process in each school district. First, we used school characteristics to select comparison schools that were similar to schools offering Saga. Second, we conducted student-level matching and weighting to identify a sample of students from the same districts who were similar to Saga students but did not participate in tutoring (in both Saga and comparison schools). Then, we used those weighted samples in a series of regression analyses to compare student outcomes for Saga students to comparison students while controlling for students' demographic characteristics and prior achievement. More information about each step of the impact analysis is provided in the subsequent sections.

School-level matching

Since not all Saga schools included enough students who could serve as strong comparisons for Saga students, we also identified comparison schools in each district. We tailored our approach to each district based on the characteristics of schools that offered Saga.

1. First, we limited the set of potential/possible comparison schools in each district based on the Saga school characteristics. For instance, in District A, all Saga schools were Title I schools and none were charter schools. We thus limited the comparison sample to Title I non-charter schools (see the first column in Table C.1). We also excluded specialized schools, such as those serving primarily non-traditional students.
2. Second, we implemented statistical matching approaches using school characteristics that were most strongly associated with Saga implementation status within each district (and that could also be associated with student outcomes). These school characteristics differed slightly by district but always included prior test scores and student demographic characteristics (see the second column in Table C.1). We also used the matching methods that produced the most similar samples of Saga and comparison schools in each district, which included Mahalanobis distance matching in District A and propensity score matching in District B. Because only three schools fit our initial eligibility criteria in District B, we did not need to conduct any matching and instead included all three schools in our comparison sample.

Table C.1. School-level screening criteria and matching characteristics for comparison schools

	Initial screening criteria	Matching characteristics	Final sample size
District A	Title I schools Non-charter schools	Algebra scale score Percent Black or Hispanic Percent eligible for free or reduced-price lunch	6 Saga schools 6 comparison schools

	Initial screening criteria	Matching characteristics	Final sample size
District C	Title I eligible schools Non-charter schools Nonspecialized schools	Percent Black, Hispanic, free- or reduced-price lunch Enrollment in grades 9 and 10 Percent female Average PSAT score	17 Saga schools 19 comparison schools
District B	Majority of students are eligible for free or reduced-price lunch Majority of students are Black or Hispanic Nonspecialized schools	n.a.	3 Saga schools 3 comparison schools

Note: We only included schools in our potential comparison sample if they passed the initial screening criteria. For example, in District A, we excluded all non-Title I schools. We then used the matching characteristics to prioritize schools that were more similar to Saga schools.

n.a. = not applicable.

Student-level matching

We defined students' Saga participation status as follows:

- **Saga student.** A student who enrolled in Saga within the first three weeks of the school year and who attended at least one Saga session at any point during the school year. Although most of these students attended Saga schools, our sample also includes a few Saga students who transferred to and primarily attended a comparison school during the 2021–2022 school year.
- **Comparison student.** A student who attended a Saga school or a comparison school and did not attend any Saga sessions during the school year. Saga students who enrolled late in the program (and thus are not considered to be Saga students) and attended at least one Saga session are also excluded from the comparison group.

Using these definitions, we conducted matching and weighting at the student level using the covariate balancing propensity score (CBPS) method. CBPS is an approach to calculating propensity scores that both estimates the likelihood of treatment among the comparison group and maximizes balance on the covariates using weights. In their seminal paper introducing the method, Imai and Ratkovic (2014) replicated a randomized controlled trial and demonstrated that the method reduced covariate imbalance as well as the bias of impact estimates relative to other propensity score matching methods. We used the *psweight* package of commands in Stata. We estimated the weights using the "treatment effect on the treated" approach so that weighted data reflects the effect of Saga on the specific population of students that participated in Saga rather than the overall population of the students in these schools.

We conducted the matching process separately for each district both because of differences in administrative data and Saga selection approaches between districts and because this approach allowed us to select the matching variables that most strongly predicted Saga participation in each district. Because the COVID-19 pandemic continued to affect student course and test-taking patterns through the 2021–2022 school year, and because we found there were larger than expected numbers of Saga students who did not have complete standardized test scores and math grades, we also conducted the matching process separately for each outcome in order to maximize statistical power and representation of the population of Saga students in our analysis sample. Our analysis used a complete case approach, meaning that students who were missing data on either the outcome or the variables used for matching were excluded from the analysis. Our approach allowed the model to select the optimal balance of weights without explicitly accounting for whether comparison students attended a Saga or comparison school, but we included school characteristics in the matching model to enhance the likelihood that both student and school characteristics would be similar in the Saga and comparison samples. Table C.2 provides additional details on the construction of the variables used in matching and other analysis steps.

Appendix D provides tables showing the overall covariate balance between the groups for our overall analysis within districts, as well as information on baseline equivalence for student subgroups in terms of math standardized test scores.

Table C.2. Student-level matching variables, by district

Matching variable category	School district		
	District A	District C	District B
School-level characteristics			
School-level characteristics	• Percent of students who are Black or Hispanic (2020–2021) • Percent of students eligible for free or reduced-price lunch • Enrollment in grade 9 (2020–2021) • Magnet school status	• Percent of students eligible for free or reduced-price lunch • Enrollment in grade 9 (2020–2021) • Percent of students who are Black or Hispanic (2020–2021) • Pupil-teacher ratio • Magnet school status	• Percent of students who are Black or Hispanic (2020–2021) • Enrollment in grade 9 (2020–2021) • Pupil-teacher ratio (2020–2021)
Student-level characteristics			
Baseline math achievement	• State standardized test math score (2018–2019) • Student math grade (2020–2021) • Student failed a previous math course (2018–2019 or 2020–2021) • Student had taken an honors math course (2018–2019 or 2020–2021) • Student math course type (algebra, geometry, or other)	• State standardized test math score 2019 math score • Northwestern Evaluation Association (NWEA) Measures of Academic Progress (MAP) spring 2019 math score • Student math grade (2020–2021) • Student failed a previous math course (2018–2019 or 2020–2021) • Student math course type (algebra, geometry, or other; math grade outcome only)	• State standardized test math score (2018–2019) • Student math grade (2020–2021) • Student failed a previous math course (2018–2019 or 2020–2021)
Other prior achievement	• Student attendance (2020–2021) • State standardized test reading score (2018–2019) • English grade (2020–2021; GPA outcome only)	• Student attendance (2020–2021) • NWEA MAP spring 2019 reading score • English grade (2020–2021; GPA outcome only)	• Student attendance (2020–2021) • State standardized test reading score (2018–2019)

Matching variable category	School district		
	District A	District C	District B
			• English grade (2020–2021; GPA outcome only)
Student demographic characteristics	• Student age • Student grade • Student ethnicity • Student race • Student is an English learner • Student is special education or has a disability	• Student age • Student grade (grades 9 and 10 weighted separately) • Student ethnicity • Student race • Student is an English learner • Student is special education or has a disability • Student gender	• Student age • Student grade • Student ethnicity • Student race • Student is an English learner

Data collection

Principal survey

We conducted a survey of school staff or other staff who were familiar with math programming at the school, such as math department directors, to understand the instructional context in Saga and comparison schools. The survey included questions about math classes, math curricula and instructional tools, and access to tutoring. School staff from Saga schools also answered questions about their perceptions of Saga implementation. We conducted the survey in spring 2022. The principal survey achieved an overall response rate of 65 percent across the three study districts (77 percent of Saga schools; 54 percent of comparison schools).

Site director interviews

We conducted 10 interviews with Saga site directors to learn more about Saga implementation. The interviews discussed topics on implementation challenges and successes including the use of technology, tutor management and coaching, managing relationships with school staff, and student attendance. In two of three districts, the study team selected all available site directors for interviews. In a third district, the study team stratified schools into four groups based on student attendance and tutor caseloads and then selected one site director from each stratum while purposively drawing a mix of experienced and newer site directors. We achieved a 100 percent response rate for sampled schools.

Saga implementation data

After the completion of the 2021–2022 school year, Saga staff provided a variety of tutor-level and school-level data, as well as de-identified student-level data from its internal data management systems. These datasets included indicators on tutoring dosage, attendance, staffing levels, and staff satisfaction.

Data sources for the impact analysis

For the impact analysis, we used a combination of publicly available school-level data, de-identified student-level data from districts, and de-identified program data from Saga. We used the school-level data to identify comparison schools, and these datasets included (A) the Common Core of Data from the National Council of Education Statistics, which includes data on school characteristics (for example, magnet and charter status) and aggregate student characteristics; and (B) publicly available results of average standardized test achievement by school. We also obtained de-identified student-level administrative data from three districts that included information on students' standardized test scores, grades and GPA, attendance, and demographic information. Prior to anonymizing data and sharing it with Mathematica, districts identified which students met the study's definition of Saga students by linking internal data with program data from Saga using student IDs.

Analytic methods

Study measures

Table C.3 describes the construction of key analysis variables in each school district.

Table C.3. Key analysis variables, by district

Variable	District A	District B	District C
Outcomes			
Student standardized test outcomes	For discussion in this report, we converted the outcomes to standard deviation units using the means and standard deviations of the analysis sample from their district, (aggregating across Saga and comparison students). This enables comparisons between the different standardized tests included in the study. Impacts on raw standardized test scores are also provided in Appendix D, which also includes analyses of impacts on standardized test scores standardized to state-level means and standard deviations.		
Student math grade outcomes	**General note:** In cases where a student took more than one math class per school year, we selected a primary math grade, which prioritized algebra classes, followed by geometry classes, and then all other math classes. When a student took more than one class within these three math topic areas (for example, more than one geometry course), we prioritized grades from courses that were most common for each grade. Student matching and impact analyses controlled for student course type (algebra, geometry, and other) to ensure that the analyses were based on similar distributions of math courses among Saga and comparison students.		
Numeric math grade in primary math class	We converted district-provided letter grades to numeric grade variable using the conversion system provided on the district website. If a full-year grade was not available, we averaged across semester grades. "Pass" grades were treated as missing. If a course was taken multiple times, the first grade (the non-retake) was used.	The district provided numeric grades ranging from 0 to 100.	We converted semester-level math letter grades to a measure of their full-year "math GPA" (on a 0 to 4 scale) using the conversion system provided on the district website and then averaging them.
Math letter grade in primary math class variables (A, B, C, D, F)	We used district-provided letter grades where available. If the full-year grade was missing, we estimated the full-year grade by converting letter grades to a numeric value, using district grading policies, averaging the values together, and converting	District-provided letter grades.	We used district-provided letter grades where available. If the full-year grade was not provided, we estimated the full-year grade by converting letter grades to a "math GPA" from 0 to 4, using district

Variable	District A	District B	District C
	this value back to a letter grade using the district policy.		grading policies, averaging the values together, and converting this value back to a letter grade using the district policy.
Passed primary math class	1 = primary math class letter grade was A through D or P (passed) 0 = grade was F or I (incomplete)	1 = primary math class grade was 60 or greater 0 = 59 or less	1 = primary math class letter grade was A through D or P (passed)
Student GPA	Unweighted GPA provided by the district, ranging from 0.0 to 4.0		
Attendance	Equals the number of days a student attended school, divided by the number of days a student was enrolled, multiplied by 100. If a student's record showed that the number of days attended exceed number of days enrolled, the value was set to 100.		
Covariates			
Race—Black	Equals 1 if student is Black, including students of multiple races in which one identified race is Black		
Ethnicity—Hispanic or Latino	Equals 1 if student is Hispanic or Latino, including students of multiple races in which one identified race is Hispanic or Latino		
Special education or disability	Equals 1 if a student was in a special education program or had a disability, or both		
Math honors	Equals 1 if a student has a history of taking at least one honors math class during either the 2018–2019 or 2019–2020 school years.		
Failed math	Equals 1 if a student has a history of receiving an F or I (incomplete) in a math class during either the 2018–2019 or 2019–2020 school years.		
Implementation characteristics			
Tutor caseloads	The number of students enrolled in Saga from a school at one time divided by the number of tutors assigned to that school at that time.		
Group sizes / student-tutor ratios	The number of students assigned to a particular tutor during a particular class period. Values reported in this report were top-coded to the 99th percentile to account for extreme values (which were largely temporary) and other data issues, and then averaged over the course of the school year.		
Student attendance in Saga	The total percentage of Saga sessions attended while enrolled. Excused absences are excluded from both the numerator and denominator of this calculation.		

Estimating the effects of Saga tutoring

To generate the impact estimates, we conducted regression analysis using the matched and weighted samples. The outcome was regressed on a binary indicator of whether a student participated in Saga and a set of covariates. These covariates included student baseline math achievement (including the same standardized tests and math grades used for matching), student demographic characteristics, and some school-level contextual characteristics that were used for matching. We then calculated effect sizes using the regression means and the Hedges' g calculation with a small sample adjustment for continuous outcomes and the Cox index for binary outcomes.

To calculate school-level impacts for correlational analysis, we ran the same regressions used for the main analyses but added interaction terms between school identifiers and Saga status. We report the addition of the coefficient on Saga and the coefficient on that interaction term as the school-level impact. We then calculated the Pearson's r correlation coefficient between these impact estimates, measures of program implementation from Saga data such as dosage and attendance, and school-level characteristics from the Common Core of Data.

When estimating impacts for closely related outcomes within the same district (for example, math letter grades, math failure, and numeric math grades), we applied the Benjamini-Hochberg correction for multiple comparisons to the calculated p-values to assess statistical significance. We also estimated Bayesian impact estimates for all impacts on standardized tests using the BAyeSian Interpretation of Estimates (BASIE) tool, which implements Bayesian analysis using information from the What Works Clearinghouse database to inform a "prior distribution" that reflects relevant past research findings (Deke et al., 2022). These estimates incorporate information from hundreds of other education studies on math outcomes, which inform the probability that the current study improved student outcomes.

Meta-analytic approach

To combine the impact estimates for similar analyses across districts, we assigned each analysis to one of four outcome domains: standardized tests, math grades, overall GPA, and student attendance. We then used the *meta* package in Stata to estimate meta-analytic effect sizes (for each domain, both overall and for each subgroup). We selected the common effects approach to calculating effect sizes, which account for the variance associated with each impact estimate. As with the overall estimates, the reported meta-analytic effect size formulas use Hedges' g for continuous outcomes and the Cox Index for binary outcomes. Our subgroup analysis included only findings for which the subgroup in a district demonstrated satisfactory equivalence on math standardized test scores based on the What Works Clearinghouse standard, meaning that the baseline Hedges' g for the weighted analytic sample was between –0.25 and 0.25 sample standard deviations. We also apply a Benjamini-Hochberg correction to the main outcomes from each district within each of our four outcome domains of interest: standardized test scores, math grade, student GPA, and student attendance.

Appendix D. Supplementary tables

This appendix provides additional information about the samples and results of the impact analyses presented in this report. This information can be used to explore the findings in additional detail, learn more about the student characteristics that underly these findings, and assess and report on the study according to What Works Clearinghouse (WWC) Standards.

- Table D.1. provides the detailed results of the overall analyses in each district, as well as the meta-analytic effect sizes for each of the four main types of outcomes: standardized test scores, math grades, student GPA, and student attendance.
- Table D.2. provides the district-level impacts on each of the outcomes and meta-analytic effect sizes for different student subgroups where the subgroup for two or more districts satisfied WWC baseline equivalence requirements (by having an effect size for pre-Saga standardized math tests between -0.25 and 0.25 standard deviations). It also provides summary statistics for these pre-Saga test scores alongside each set of results.
- Tables D.3. provides overall demographic and select school-level characteristics of the students from each district who were included in the study. It corresponds to the samples for the student attendance outcomes, since these were the largest samples in each district.
- Tables D.4A-D.4L provide student pre-Saga achievement information, including student standardized test scores, math grades, and attendance for each unique sample of students included in overall findings (Table D.1).
- Table D.5. provides anonymized school-level impacts on math grades and standardized test scores and its correlation with student-tutor ratios.

Table D.1. Overall impact estimates, by outcome domain

Outcome	District	Impact of Saga	p-value	Standard error	Regression-adjusted means (SDs)		Effect size (CI for domain-level findings)	Sample sizes	
					Saga	Comparison		Saga	Comparison
Student standardized test scores							**0.01 (-0.04, 0.05)**		
Algebra EOC score (425-575)	District A	-0.83	0.51	1.25	470.37 (26.7)	471.2 (27.35)	-0.03	441	4202
Geometry EOC score (425-575)	District A	6.53	0.05	3.39	477.43 (26.27)	470.9 (26)	0.25	65	3672
Algebra EOC score (0-100)	District B	3.24	0.01*	1.17	62.77 (10.44)	59.53 (11.31)	0.29	149	499
PSAT Math (160-760)	District C	-1.36	0.49	1.96	372.85 (60.97)	374.21 (65.12)	-0.02	1079	11574
Student math grades							**0.08 (0.03, 0.13)**		
Math grade (0-100; F=0)[a]	District A	2.53	0.04	1.25	43.21 (29.25)	40.68 (27.48)	0.09	560	11028
A		1.10	0.35	1.18	6.76 (24.81)	5.66 (23.13)	0.11	517	10419
B		6.78	0.00	1.99	25.97 (43.65)	19.2 (39.4)	0.24	517	10419
C		-5.66	0.01	2.25	29.63 (45.69)	35.29 (47.79)	-0.16	517	10419
D		-5.42	0.01	2.08	23.38 (42.62)	28.8 (45.28)	-0.17	517	10419
F		3.21	0.04	1.59	14.26 (35.25)	11.05 (31.34)	0.18	517	10419
Math grade (0-100, F=0-50)[b]	District B	1.66	0.19	1.27	64.67 (13.32)	63.01 (16.58)	0.10	290	993
A		-0.35	0.71	0.95	1.75 (13.04)	2.11 (14.39)	-0.12	290	993
B		0.46	0.85	2.43	11.48 (31.81)	11.02 (31.37)	0.03	290	993
C		1.08	0.77	3.60	25.19 (43.28)	24.12 (42.87)	0.03	290	993
D		-2.07	0.63	4.27	36.61 (48.34)	38.68 (48.71)	-0.05	290	993
F		0.89	0.81	3.76	24.96 (43.48)	24.07 (42.73)	0.03	290	993
Math grade (GPA points, 0-4)[c]	District C	0.09	0.03	0.04	2.20 (1.26)	2.11 (1.25)	0.07	1229	12594
A		3.27	0.01	1.20	19.65 (40.09)	16.38 (36.97)	0.13	1229	12594
B		-0.49	0.73	1.43	23.42 (42.83)	23.9 (42.61)	-0.02	1229	12594
C		-1.27	0.38	1.44	23.88 (42.88)	25.15 (43.37)	-0.04	1229	12594
D		-0.56	0.70	1.44	22.88 (41.48)	23.44 (42.41)	-0.02	1229	12594
F		-0.96	0.35	1.01	10.17 (29.25)	11.13 (31.53)	-0.06	1229	12594

Table D.1 *(continued)*

Outcome	District	Impact of Saga	p-value	Standard error	Regression-adjusted means (SDs)		Effect size (CI for domain-level findings)	Sample sizes	
					Saga	Comparison		Saga	Comparison
Student grade point average (GPA)							**-0.01 (-0.05, 0.03)**		
Student GPA (0-4)	District A	-0.05	0.11	0.03	2.02 (.86)	2.07 (.92)	-0.05	560	11029
	District B	-0.06	0.32	0.06	1.66 (.79)	1.71 (.88)	-0.06	294	986
	District C	0.06	0.02	0.02	2.4 (.89)	2.35 (.92)	0.05	1240	12830
Attendance at school							**-0.08 (-0.12, -0.03)**		
School attendance (percentage points)	District A	-0.74	0.10	0.45	87.9 (11.77)	88.64 (11.11)	-0.07	560	11029
	District B	2.44	0.03	1.11	83.3 (14.18)	80.86 (19.03)	0.13	329	1163
	District C	-2.82	0.00**	0.57	73.31 (20)	76.13 (20.2)	-0.14	1240	12831

Source: District administrative data

Note: Group-level effect sizes reflect the inverse variance-weighted (common effects) Hedges' g and corresponding 95 percent confidence interval across all districts. Baseline means, standard deviations and effect sizes reflect student-level results on state standardized tests from the 2018-2019 school year: FSA math for District A, SC Ready math for District B, and the NWEA Math, spring administration for District C. Statistical significance estimates have been adjusted for multiple comparisons within each category of findings. For more information on the analysis approach see Appendix C.

[a] A= 100; B=75; C=50; D=25; F or I=0; for "+" add an additional 2.5 points to the value of the corresponding letter grade

[b] A=90 to 100; B=80-89; C=70-79; D=60-69.; F=0-59

[c] A=4, B=3; C=2; D=1, and F=0

Table D.2. Subgroup impacts and baseline information

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
Standardized test scores												
Students with below-median math standardized test scores at baseline | Effect size: 0.10 (0.02, 0.17)												
Algebra/Geometry EOC score combined[a]	District A	-0.03	0.59	0.05	-0.04	-1.2 (0.77)	-1.17 (0.75)	225	2319	-1.31 (0.62)	-1.29 (0.61)	-0.03
Algebra EOC score 0-100)	District B	3.62	0.03	1.66	0.41	58.06 (8.16)	54.44 (9.28)	77	117	-1.29 (0.17)	-1.33 (0.2)	0.21
PSAT Math[b]	District C	7.32	0.01	2.94	0.13	355.42 (55.13)	348.1 (56.39)	488	3579	-1.12 (0.53)	-1.19 (0.63)	0.12
Hispanic students | Effect size: 0.01 (-0.07 , 0.08)												
Algebra/Geometry EOC score combined (SD units)	District A	0.13	0.02	0.06	0.15	-0.66 (0.80)	-0.79 (0.89)	175	2275	-0.61 (0.8)	-0.57 (0.84)	-0.05
PSAT Math	District C	-2.34	0.42	2.92	-0.04	375.75 (63.07)	378.09 (63.41)	566	6793	-0.49 (0.8)	-0.3 (0.97)	-0.20
Female students | Effect size: 0.04 (-0.03, 0.11)												
Algebra/Geometry EOC score combined (SD units)	District A	-0.01	0.85	0.05	-0.01	-0.74 (0.82)	-0.73 (0.82)	238	3556	-0.68 (0.7)	-0.62 (0.79)	-0.07
Algebra EOC score	District B	3.68	0.02	1.59	0.31	61.49 (10.2)	57.81 (12.07)	75	242	-0.99 (0.39)	-1.03 (0.48)	0.10
PSAT Math	District C	2.22	0.44	2.86	0.03	375.93 (61.07)	373.71 (64.54)	500	5731	-0.42 (0.84)	-0.31 (0.98)	-0.11
Male students | Effect size: -0.03 (-0.09, 0.04)												
Algebra/Geometry EOC score combined (SD units)	District A	0.01	0.89	0.05	0.00	-0.83 (0.88)	-0.83 (0.91)	266	3624	-0.64 (0.8)	-0.69 (0.89)	0.06
Algebra EOC score	District B	2.45	0.13	1.63	0.24	63.88 (10.72)	61.42 (10.05)	74	257	-0.95 (0.45)	-0.9 (0.4)	-0.13
PSAT Math	District C	-4.27	0.11	2.69	-0.07	370.36 (60.91)	374.63 (65.61)	579	5843	-0.42 (0.78)	-0.36 (1.01)	-0.07

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
Grade 10 | Effect size: -0.04 (-0.14, 0.07)												
Algebra/Geometry EOC score combined (SD units)	District A	0.00	0.98	0.06	0.00	-0.88 (0.83)	-0.88 (0.83)	154	3579	-0.77 (0.78)	-0.91 (0.84)	0.16
PSAT Math	District C	-3.45	0.31	3.37	-0.06	383.92 (48.35)	387.37 (60.55)	218	6117	-0.21 (0.77)	-0.21 (0.96)	0.00
Grade 9 | Effect size: -0.01 (-0.07, 0.06)												
Algebra/Geometry EOC score combined (SD units)	District A	0.01	0.90	0.04	0.01	-0.74 (0.86)	-0.75 (0.88)	350	3601	-0.6 (0.74)	-0.54 (0.82)	-0.07
PSAT Math	District C	-0.95	0.68	2.33	-0.01	360.09 (62.89)	361.04 (67.21)	861	5457	-0.48 (0.81)	-0.48 (1.01)	0.00
Prior math grade C or above | Effect size: 0.01 (-0.05, 0.07)												
Algebra/Geometry EOC score combined (SD units)	District A	0.01	0.80	0.04	0.01	-0.65 (0.83)	-0.66 (0.86)	324	4916	-0.66 (0.73)	-0.57 (0.8)	-0.11
Algebra EOC score	District B	5.63	0.00	1.94	0.48	67.04 (9.84)	61.42 (11.89)	52	313	-0.98 (0.37)	-0.88 (0.48)	-0.22
PSAT Math	District C	-1.12	0.64	2.36	-0.02	378.29 (60.38)	379.41 (66.03)	701	8916	-0.39 (0.83)	-0.25 (1.01)	-0.13
Prior math grade D or below | Effect size: 0.01 (-0.08, 0.09)												
Algebra/Geometry EOC score combined (SD units)	District A	-0.01	0.86	0.06	-0.01	-1.02 (0.87)	-1.01 (0.84)	180	2264	-0.65 (0.79)	-0.81 (0.9)	0.18
Algebra EOC score	District B	2.01	0.15	1.40	0.19	60.39 (10.62)	58.37 (10.67)	97	186	-0.96 (0.45)	-1.03 (0.41)	0.15
PSAT Math	District C	-1.17	0.74	3.55	-0.02	363.67 (61.28)	364.84 (62.35)	378	2658	-0.49 (0.76)	-0.49 (0.95)	-0.01
Black students | Effect size: 0.08 (0.0, 0.15)												
Algebra/Geometry EOC score	District A	-0.07	0.16	0.05	-0.08	-0.89 (0.87)	-0.82 (0.85)	282	3919	-0.7 (0.72)	-0.75 (0.83)	0.07

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
combined (SD units)												
Algebra EOC score	District B	4.69	0.00	1.22	0.47	61.9 (10.16)	57.21 (9.93)	109	287	-0.99 (0.42)	-1.02 (0.44)	0.07
PSAT Math	District C	6.71	0.03	3.03	0.11	372.04 (57.18)	365.33 (62.71)	449	3894	-0.35 (0.79)	-0.43 (0.98)	0.09
Math grades												
Students with below-median math standardized test scores at baseline | Effect size: 0.04 (-0.03, 0.11)												
Math grade (District point system)[c]	District A	-2.64	0.15	1.85	-0.10	32.12 (28.63)	34.76 (24.95)	259	3369	-1.31 (0.63)	-1.37 (0.64)	0.09
Math grade (Percentage points)[d]	District B	-1.01	0.60	1.95	-0.07	60.59 (13.27)	61.6 (16.36)	145	251	-1.31 (0.18)	-1.36 (0.22)	0.22
Math grade (GPA points)[e]	District C	0.16	0.01	0.06	0.13	2.04 (1.22)	1.88 (1.21)	565	4076	-1.12 (0.53)	-1.21 (0.64)	0.14
Hispanic students | Effect size: 0.07 (0.03, 0.16)												
Math grade (District point system)	District A	2.02	0.37	2.27	0.07	43.9 (31.25)	41.87 (27.19)	199	3373	-0.65 (0.83)	-0.56 (0.95)	-0.10
Math grade (Percentage points)	District B	3.33	0.15	2.30	0.23	66.69 (12.23)	63.36 (15.49)	84	197	-0.98 (0.4)	-0.93 (0.45)	-0.11
Math grade (GPA points)	District C	0.11	0.04	0.06	0.09	2.25 (1.29)	2.14 (1.28)	630	7341	-0.49 (0.82)	-0.3 (1.01)	-0.19
Female students | Effect size: 0.05 (-0.02, 0.12)												
Math grade (District point system)	District A	2.24	0.22	1.81	0.08	45.63 (28.65)	43.39 (27.56)	259	5442	-0.69 (0.7)	-0.6 (0.91)	-0.10
Math grade (Percentage points)	District B	-0.63	0.69	1.56	-0.05	65.58 (13.29)	66.21 (13.14)	129	492	-1.01 (0.38)	-1.01 (0.49)	0.00
Math grade (GPA points)	District C	0.07	0.23	0.06	0.06	2.3 (1.28)	2.23 (1.25)	575	6191	-0.46 (0.85)	-0.34 (1)	-0.12
Male students | Effect size: 0.10 (0.04, 0.16)												

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
Math grade (District point system)	District A	2.76	0.11	1.73	0.10	41.11 (29.71)	38.35 (27.2)	301	5586	-0.66 (0.82)	-0.74 (1)	0.08
Math grade (Percentage points)	District B	3.27	0.07	1.81	0.18	63.35 (13.34)	60.09 (18.85)	161	501	-0.96 (0.48)	-0.95 (0.43)	-0.01
Math grade (GPA points)	District C	0.10	0.05	0.05	0.08	2.11 (1.24)	2.01 (1.24)	654	6403	-0.4 (0.79)	-0.37 (1.04)	-0.03
Grade 10 | Effect size: 0.34 (0.24, 0.43)												
Math grade (District point system)	District A	17.58	0.00	2.13	0.65	56.65 (29.53)	39.07 (27.02)	182	5427	-0.76 (0.8)	-0.75 (0.99)	-0.01
Math grade (GPA points)	District C	0.16	0.05	0.08	0.12	2.19 (1.32)	2.04 (1.26)	256	6636	-0.25 (0.77)	-0.25 (1.01)	0.00
Grade 9 | Effect size: 0.00 (-0.05, 0.05)												
Math grade (District point system)	District A	-4.40	0.00	1.43	-0.16	37.04 (27.21)	41.44 (27.67)	378	5601	-0.63 (0.75)	-0.64 (0.94)	0.00
Math grade (Percentage points)	District B	0.89	0.59	1.65	0.06	63.67 (14.11)	62.78 (16.58)	217	773	-1 (0.44)	-0.94 (0.46)	-0.12
Math grade (GPA points)	District C	0.06	0.13	0.04	0.06	2.25 (1.24)	2.18 (1.23)	973	5958	-0.48 (0.83)	-0.48 (1.02)	0.00
Prior math grade C or above | Effect size: 0.05 (-0.01, 0.11)												
Math grade (District point system)	District A	1.75	0.26	1.55	0.07	48.88 (28.3)	47.13 (26.48)	346	7488	-0.66 (0.74)	-0.51 (0.94)	-0.16
Math grade (GPA points)	District C	0.05	0.26	0.05	0.04	2.49 (1.22)	2.44 (1.19)	772	9363	-0.39 (0.84)	-0.26 (1.03)	-0.13
Prior math grade D or below | Effect size: 0.13 (0.04, 0.20)												
Math grade (Percentage points)	District B	1.55	0.33	1.60	0.09	62.46 (13.37)	60.91 (17.86)	211	456	-0.98 (0.45)	-1.05 (0.43)	0.17
Math grade (GPA points)	District C	0.16	0.01	0.06	0.14	1.75 (1.23)	1.59 (1.17)	457	3231	-0.49 (0.77)	-0.51 (0.98)	0.02
Non-Black, non-Hispanic students | Effect size: 0.04 (-0.18, 0.26)												

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
Math grade (District point system)	District A	3.14	0.44	4.07	0.10	45.79 (28.86)	42.65 (30.6)	61	1936	-0.51 (0.76)	-0.3 (1.01)	-0.21
Math grade (Percentage points)	District B	-1.76	0.63	3.60	-0.15	61.26 (17.91)	63.02 (10.79)	23	188	-0.89 (0.48)	-0.85 (0.44)	-0.10
Black students | Effect size: 0.11 (0.05, 0.18)												
Math grade (District point system)	District A	2.22	0.16	1.59	0.08	41.9 (28.34)	39.68 (26.9)	311	5980	-0.72 (0.72)	-0.83 (0.93)	0.11
Math grade (Percentage points)	District B	1.27	0.45	1.66	0.08	64.13 (13.09)	62.87 (17.65)	183	608	-0.99 (0.45)	-1.02 (0.47)	0.06
Math grade (GPA points)	District C	0.17	0.01	0.07	0.14	2.2 (1.22)	2.03 (1.2)	530	4339	-0.36 (0.8)	-0.45 (1)	0.09
Student grade point average (GPA)												
Students with below-median standardized test scores at baseline | Effect size: 0.02 (-0.05, 0.08)												
Student GPA (0-4)[f]	District A	-0.10	0.05	0.05	-0.10	1.71 (0.87)	1.8 (0.86)	259	3369	-1.31 (0.63)	-1.37 (0.64)	0.09
	District B	-0.13	0.15	0.09	-0.16	1.45 (0.8)	1.58 (0.8)	147	242	-1.31 (0.18)	-1.36 (0.23)	0.23
	District C	0.09	0.01	0.04	0.10	2.24 (0.85)	2.15 (0.86)	570	4198	-1.12 (0.53)	-1.2 (0.63)	0.12
Hispanic students | Effect size: 0.08 (0.02, 0.15)												
Student GPA	District A	-0.03	0.63	0.06	-0.03	2.06 (0.85)	2.09 (0.94)	199	3374	-0.65 (0.83)	-0.56 (0.95)	-0.10
	District B	0.08	0.51	0.11	0.08	1.82 (0.72)	1.75 (0.96)	86	194	-0.99 (0.41)	-0.9 (0.44)	-0.19
	District C	0.12	0.00	0.04	0.12	2.45 (0.94)	2.33 (0.99)	638	7516	-0.49 (0.81)	-0.32 (0.99)	-0.17
Female students | Effect size: -0.03 (-0.09, 0.04)												
Student GPA	District A	-0.07	0.15	0.05	-0.07	2.19 (0.86)	2.25 (0.9)	259	5442	-0.69 (0.7)	-0.6 (0.91)	-0.10
	District B	-0.15	0.09	0.09	-0.18	1.8 (0.83)	1.95 (0.81)	130	490	-1.01 (0.38)	-1.01 (0.5)	-0.01
	District C	0.03	0.40	0.03	0.02	2.52 (0.89)	2.5 (0.93)	580	6291	-0.46 (0.85)	-0.33 (0.98)	-0.13
Male students | Effect size: 0.04 (-0.02, 0.10)												
Student GPA	District A	-0.04	0.33	0.04	-0.04	1.87 (0.83)	1.91 (0.91)	301	5587	-0.66 (0.82)	-0.74 (1)	0.08
	District B	0.01	0.86	0.08	0.01	1.51 (0.75)	1.5 (0.88)	164	496	-0.96 (0.47)	-0.96 (0.43)	0.00

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD) Saga	Outcome mean (SD) Comparison	Sample sizes Saga	Sample sizes Comparison	Baseline standardized test mean (SD) Saga	Baseline standardized test mean (SD) Comparison	Baseline Effect size
	District C	0.08	0.01	0.03	0.09	2.3 (0.89)	2.22 (0.89)	660	6539	-0.41 (0.79)	-0.38 (1.02)	-0.03
Grade 10 | Effect size: -0.11 (-0.21, -0.01)												
Student GPA	District A	-0.05	0.12	0.04	-0.06	1.93 (0.86)	1.98 (0.91)	182	5428	-0.76 (0.8)	-0.75 (0.99)	-0.01
	District C	-0.13	0.00	0.03	-0.15	2.17 (0.78)	2.3 (0.88)	257	6812	-0.25 (0.77)	-0.25 (0.99)	0.00
Grade 9 | Effect size: 0.06 (0.01, 0.12)												
Student GPA	District A	-0.03	0.43	0.04	-0.03	2.09 (0.85)	2.12 (0.93)	378	5601	-0.63 (0.75)	-0.64 (0.94)	0.00
	District B	-0.06	0.45	0.07	-0.05	1.68 (0.84)	1.73 (0.93)	221	756	-1 (0.44)	-0.95 (0.46)	-0.12
	District C	0.11	0.00	0.03	0.13	2.51 (0.9)	2.39 (0.95)	983	6018	-0.48 (0.82)	-0.48 (1.01)	0.00
Prior math grade C or above | Effect size: 0.01 (-0.06, 0.07)												
Student GPA	District A	-0.01	0.80	0.04	-0.01	2.38 (0.77)	2.39 (0.82)	346	7489	-0.66 (0.74)	-0.51 (0.94)	-0.16
	District C	0.02	0.58	0.03	0.01	2.72 (0.8)	2.71 (0.8)	776	9528	-0.39 (0.84)	-0.26 (1.02)	-0.13
Prior math grade D or below | Effect size: 0.10 (0.02, 0.07)												
Student GPA	District B	-0.09	0.21	0.07	-0.12	1.41 (0.75)	1.5 (0.77)	213	432	-0.98 (0.44)	-1.06 (0.44)	0.17
	District C	0.14	0.00	0.04	0.18	1.9 (0.87)	1.76 (0.78)	464	3302	-0.49 (0.77)	-0.51 (0.96)	0.02
Non-Black, Non-Hispanic students | Effect size: -0.15 (-0.37, 0.07)												
Student GPA	District A	-0.13	0.20	0.11	-0.13	2.13 (0.86)	2.26 (1.01)	61	1936	-0.51 (0.76)	-0.3 (1.01)	-0.21
	District B	-0.20	0.33	0.20	-0.22	1.47 (0.74)	1.67 (0.93)	23	188	-0.89 (0.48)	-0.84 (0.47)	-0.12
Black students | Effect size: -0.01 (-0.07, 0.06)												
Student GPA	District A	-0.04	0.31	0.04	-0.05	1.99 (0.85)	2.03 (0.89)	311	5980	-0.72 (0.72)	-0.83 (0.93)	0.11
	District B	-0.10	0.14	0.07	-0.12	1.6 (0.82)	1.7 (0.83)	185	604	-1 (0.44)	-1.04 (0.47)	0.10
	District C	0.04	0.24	0.03	0.05	2.36 (0.79)	2.32 (0.83)	532	4370	-0.37 (0.8)	-0.44 (0.99)	0.08
School attendance												
Students with below-median standardized test scores at baseline | Effect size: -0.06 (-0.13,0.00)												
School attendance[g]	District A	-0.88	0.21	0.71	-0.07	86.83 (12.98)	87.72 (11.89)	259	3369	-1.31 (0.63)	-1.37 (0.64)	0.09
	District B	3.40	0.06	1.78	0.17	80.53 (15.73)	77.13 (21.53)	162	322	-1.31 (0.18)	-1.35 (0.23)	0.21
	District C	-2.18	0.01	0.86	-0.10	70.63 (19.56)	72.81 (20.95)	570	4198	-1.12 (0.53)	-1.2 (0.64)	0.12

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
Hispanic students | Effect size: -0.02 (-0.08, 0.05)												
School attendance	District A	-1.03	0.14	0.70	-0.10	87.48 (11.35)	88.52 (10.31)	199	3374	-0.65 (0.83)	-0.56 (0.95)	-0.10
	District B	3.36	0.09	2.00	0.20	85.32 (13.01)	81.96 (18.7)	96	226	-0.99 (0.42)	-0.9 (0.48)	-0.19
	District C	-0.27	0.76	0.88	-0.01	77.45 (20.33)	77.72 (20.29)	638	7516	-0.49 (0.81)	-0.32 (0.99)	-0.17
Female students | Effect size: -0.14 (-0.21, -0.08)												
School attendance	District A	-0.87	0.20	0.69	-0.08	87.16 (12.46)	88.03 (11.26)	259	5442	-0.69 (0.7)	-0.6 (0.91)	-0.10
	District B	0.31	0.83	1.45	0.02	83.34 (13.86)	83.03 (16.55)	146	563	-0.99 (0.39)	-0.98 (0.51)	-0.02
	District C	-4.01	0.00	0.83	-0.21	72.46 (21.05)	76.47 (19.3)	580	6292	-0.46 (0.85)	-0.33 (0.98)	-0.13
Male students | Effect size: -0.04 (-0.10, 0.03)												
School attendance	District A	-0.60	0.30	0.58	-0.05	88.56 (11.12)	89.16 (10.95)	301	5587	-0.66 (0.82)	-0.74 (1)	0.08
	District B	4.11	0.01	1.59	0.21	82.97 (14.47)	78.85 (20.94)	183	600	-0.96 (0.47)	-0.97 (0.45)	0.02
	District C	-1.77	0.02	0.77	-0.09	74.06 (18.89)	75.83 (20.95)	660	6539	-0.41 (0.79)	-0.38 (1.02)	-0.03
Grade 10 | Effect size: -0.14 (-0.24, -0.05)												
School attendance	District A	-2.01	0.03	0.91	-0.17	84.9 (14.67)	86.91 (11.95)	182	5428	-0.76 (0.8)	-0.75 (0.99)	-0.01
	District C	-2.59	0.01	1.00	-0.13	71.86 (18.77)	74.45 (20.57)	257	6812	-0.25 (0.77)	-0.25 (0.99)	0.00
Grade 9 | Effect size: -0.08 (-0.13, -0.03)												
School attendance	District A	-0.28	0.57	0.49	-0.03	89.2 (9.55)	89.48 (10.58)	378	5601	-0.63 (0.75)	-0.64 (0.94)	0.00
	District B	1.90	0.13	1.27	0.11	83.71 (15.03)	81.8 (18.76)	251	871	-0.99 (0.45)	-0.95 (0.48)	-0.08
	District C	-2.91	0.00	0.67	-0.15	74.91 (20.27)	77.82 (19.64)	983	6019	-0.48 (0.82)	-0.48 (1.01)	0.00
Prior math grade C or above | Effect size: -0.13 (-0.19, -0.07)												
School attendance	District A	-0.69	0.15	0.48	-0.08	90.24 (9.68)	90.94 (8.89)	346	7489	-0.66 (0.74)	-0.51 (0.94)	-0.16
	District C	-2.57	0.00	0.64	-0.16	78.62 (17.39)	81.19 (16.41)	776	9529	-0.39 (0.84)	-0.26 (1.02)	-0.13
Prior math grade D or below | Effect size: -0.02 (-0.11, 0.06)												
School attendance	District B	4.64	0.00	1.34	0.24	81.43 (14.02)	76.79 (21.02)	239	564	-0.97 (0.45)	-1.05 (0.44)	0.20
	District C	-2.99	0.01	1.08	-0.13	64.92 (21.69)	67.91 (22.83)	464	3302	-0.49 (0.77)	-0.51 (0.96)	0.02
Black students | Effect size: -0.10 (-0.16, -0.04)												
School attendance	District A	-0.76	0.20	0.59	-0.07	88.26 (11.61)	89.02 (11.08)	311	5980	-0.72 (0.72)	-0.83 (0.93)	0.11

Table D.2 *(continued)*

Outcome / Subgroup	District	Saga impact	p-value	Standard error	Effect size	Outcome mean (SD)		Sample sizes		Baseline standardized test mean (SD)		Baseline Effect size
						Saga	Comparison	Saga	Comparison	Saga	Comparison	
	District B	2.19	0.11	1.38	0.12	82.42 (13.86)	80.23 (19.52)	208	713	-0.97 (0.44)	-1.03 (0.47)	0.12
	District C	-3.82	0.00	0.88	-0.19	70.09 (19.27)	73.91 (19.93)	532	4371	-0.37 (0.8)	-0.44 (0.99)	0.08

Source: District administrative data

Note: Subgroup-specific regression results were calculated using the same approach and covariates as for overall results; for more information on the analysis approach see Appendix C. Group-level effect sizes reflect the inverse variance-weighted (common effects) Hedges' g and corresponding 95 percent confidence interval for all districts in which the sub-sample of students had a baseline effect store on standardized tests of between -0.25 and 0.25. Outcomes for which only one district's sub-sample satisfied this requirement are not reported. Baseline means, standard deviations and effect sizes reflect student-level results on state standardized tests from the 2018-2019 school year: state standardized math tests for Districts A and B, and the NWEA Math, spring administration for District C.

[a] Geometry and Algebra EOC scores were each standardized based on state-level means and standard deviations and then combined, prioritizing Algebra for grade 9 and Geometry for grade 10 in the few cases that a student had both scores. The weighting and impact analysis included indicators for which type of exam a student took. We use the combined estimate because the sample size for the geometry EOC exam is too small for subgroup analyses.

[b] PSAT math scores range from 160 to 760.

[c] A= 100; B=75; C=50; D=25; F or I=0; for "+" add an additional 2.5 points to the value of the corresponding letter grade

[d] A=90 to 100; B=80-89; C=70-79; D=60-69.

[e] A=4, B=3; C=2; D=1, and F=0

[f] A=4, B=3; C=2; D=1, and F=0

[g] Attendance reported in percentage points (0-100).

Table D3. Demographic characteristics of the analysis sample by district

Student demographic characteristics (%)	District A		District B		District C	
	Saga	Comparison	Saga	Comparison	Saga	Comparison
Grade (%)						
Grade 9	67.50	67.50	76.3	76.3	79.3	46.9
Grade 10	32.5	32.5	23.7	23.7	20.7	53.1
Gender (%)						
Female	46.3	46.3	44.4	49.2	46.8	46.6
Male	53.8	53.8	55.6	50.8	53.2	53.4
Race (%)						
Black	53.1	53.6	63.2	63.2	42.9	51.0
White	42.2	41.6	5.8	5.9	3.4	3.5
Asian	1.4	1.4	0.0	0.2	1.1	1.6
Hawaiian/Pacific Islander	0.2	0.4	0.0	0.0	0.1	0.1
American Indian	0.5	0.7	0.0	0.1	0.3	0.4
Multiple races	2.7	2.3	1.8	1.5	0.8	0.5
Ethnicity (%)						
Hispanic or Latino	35.5	35.5	29.2	29.2	51.5	43.0
Not Hispanic or Latino	64.5	64.5	70.8	70.8	48.6	57.0
Other student characteristics (%)						
English Learners	3.4	3.4	27.1	27.1	21.3	14.7
Special education or disability	22.1	22.1	24.3	19.0	27.4	26.4
School characteristics						
Magnet school (%)	58.0	58.0	0.0	0.0	18.8	11.4
Eligible for free and reduced-price lunch (school-level average, %)	72.1	72.1	100.0	100.0	89.0	88.0
Average school student enrollment (Grade 9)	516.8	516.8	505.8	505.8	335.6	322.1
Sample size	560	11029	329	1163	1240	12831

Source: District administrative data and NCES Common Core of Data (CCD)

Note: This table reflects reflect the weighted analysis samples for student attendance, which is the largest sample for each district. Demographic balances in the District C sample primarily results from weighting students in grade 9 separately from students in grade 10, and then aggregating the two samples. The two samples are separately equivalent on most characteristics, and in addition to achievement and demographic characteristics, the subsequent regression analysis controls for the interaction between student grade level and prior standardized test scores.

Table D.4A-D4L. Prior student achievement characteristics by district and analysis sample

Note: All students in the analysis samples had complete data for all variables shown. Effect sizes represent Hedges' g for continuous outcomes and the Cox Index for binary or dichotomous outcome

Source: Study districts' administrative data

D.4A. District A Algebra EOC sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.71 (0.75)	-0.71 (0.82)	0.00
State standardized test in reading, 2018-19 (standardized to state averages)	-0.64 (0.78)	-0.64 (0.89)	-0.00
Math grade (2020-21, %)			
A or B	40.36 (49.12)	38.87 (48.75)	0.03
C	27.21 (44.56)	27.97 (44.89)	-0.02
D or F	32.2 (46.78)	32.79 (46.95)	-0.01
Failed a previous math class (%)	20.41 (40.35)	20.41 (40.31)	0.00
Previously took an honors math class (2018/19 or 2020-21, %)	17.01 (37.61)	17.01 (37.57)	0.00
Attendance (2018-19, %)	95.75 (3.99)	95.99 (3.98)	-0.06
Attendance (2020-21, %)	92.71 (9.87)	92.71 (11.26)	-0.00
Sample size	441	4202	

D.4B. District A Geometry EOC sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.28 (0.64)	-0.28 (0.74)	0.00
State standardized test in reading, 2018-19 (standardized to state averages)	-0.22 (0.75)	-0.22 (0.77)	0.00
Math grade (2020-21, %)			
A or B	9.23 (29.17)	12.09 (32.61)	-0.09
C	32.31 (47.13)	27.92 (44.86)	0.10
D or F	56.92 (49.9)	58.92 (49.21)	-0.04
Failed a previous math class (%)	16.92 (37.79)	16.92 (37.5)	0.00
Previously took an honors math class (2018/19 or 2020-21, %)	33.85 (47.69)	33.85 (47.33)	0.00
Attendance (2018-19, %)	94.87 (4.07)	94.79 (4.59)	0.02
Attendance (2020-21, %)	86.84 (15.04)	86.84 (18.73)	0.00
Sample size	65	3672	0.00

D4C. District A math grade sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.67 (0.77)	-0.67 (0.96)	0.00
State standardized test in reading, 2018-19 (standardized to state averages)	-0.6 (0.8)	-0.6 (0.96)	0.00
Math grade (2020-21, %)			
A or B	34.82 (47.68)	34.05 (47.39)	0.02
C	26.96 (44.42)	27.12 (44.46)	0.00
D or F	37.86 (48.55)	38.31 (48.62)	-0.01
Failed a previous math class (%)	21.96 (41.44)	21.96 (41.4)	0.00
Previously took an honors math class (2018/19 or 2020-21, %)	18.75 (39.07)	18.75 (39.03)	0.00
Attendance (2018-19, %)	95.3 (4.45)	95.64 (4.44)	-0.08
Attendance (2020-21, %)	90.95 (12.52)	90.95 (13.4)	0.00
Sample size	560	11028	0.00

D4D. District A attendance and GPA sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.67 (0.77)	-0.67 (0.96)	0.00
State standardized test in reading, 2018-19 (standardized to state averages)	-0.6 (0.8)	-0.6 (0.96)	0.00
Math grade (2020-21, %)			
A or B	34.82 (47.68)	34.05 (47.39)	0.02
C	26.96 (44.42)	27.12 (44.46)	0.00
D or F	37.86 (48.55)	38.31 (48.62)	-0.01
Failed a previous math class (%)	21.96 (41.44)	21.96 (41.4)	0.00
Previously took an honors math class (2018/19 or 2020-21, %)	18.75 (39.07)	18.75 (39.03)	0.00
Attendance (2018-19, %)	95.3 (4.45)	95.64 (4.44)	-0.08
Attendance (2020-21, %)	90.95 (12.52)	90.95 (13.4)	0.00
Sample size	560	11029	

D4E. District B Algebra EOC sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.97 (0.42)	-0.97 (0.45)	0.00
Math grade (2020-21)			
A or B	9.4 (29.28)	16.6 (37.24)	-0.20
C	25.5 (43.74)	21.92 (41.41)	0.09
D or F	65.1 (47.83)	61.48 (48.71)	0.07
Failed a previous math class	24.83 (43.35)	24.83 (43.25)	0.00
Previously took an honors math class (2018/19 or 2020-21)	0 (0)	0 (0)	n/a
Attendance (2018-19)	94.21 (6.14)	93.51 (6.35)	0.11
Attendance (2020-21)	88.32 (13.24)	88.33 (12.23)	0.00
Sample size	149	499	

D4F. District B math grade sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.98 (0.44)	-0.98 (0.46)	0.00
Math grade (2020-21)			
A or B	7.59 (26.52)	15.15 (35.87)	-0.22
C	19.66 (39.81)	19.87 (39.92)	-0.01
D or F	72.76 (44.6)	64.98 (47.73)	0.17
Failed a previous math class	42.41 (49.51)	42.41 (49.45)	0.00
Previously took an honors math class (2018/19 or 2020-21)	0 (0)	0 (0)	n/a
Attendance (2018-19)	93.96 (6.24)	93.95 (6.27)	0.00
Attendance (2020-21)	85.68 (14.78)	85.68 (15.2)	0.00
Sample size	290	993	

D4G. District B GPA sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.98 (0.43)	-0.98 (0.47)	0.00
Math grade (2020-21)			
A or B	7.82 (26.9)	14.86 (35.59)	-0.21
C	19.73 (39.86)	20.3 (40.24)	-0.01
D or F	72.45 (44.75)	64.84 (47.77)	0.16
Failed a previous math class	42.52 (49.52)	42.59 (49.47)	0.00
Previously took an honors math class (2018/19 or 2020-21)	0 (0)	0 (0)	n/a
Attendance (2018-19)	93.93 (6.24)	94.28 (5.64)	-0.06
Attendance (2020-21)	85.52 (14.87)	85.49 (15.78)	0.00
Sample size	294	986	

D4H. District B attendance sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
State standardized test in math, 2018-19 (standardized to state averages)	-0.97 (0.44)	-0.97 (0.48)	0.00
Math grade (2020-21)			
A or B	8.21 (27.49)	14.95 (35.67)	-0.20
C	19.15 (39.41)	20.29 (40.23)	-0.03
D or F	72.64 (44.65)	64.77 (47.79)	0.17
Failed a previous math class	43.16 (49.61)	43.16 (49.55)	0.00
Previously took an honors math class (2018/19 or 2020-21)	0 (0)	0 (0)	.
Attendance (2018-19)	93.65 (6.31)	93.46 (7.32)	0.03
Attendance (2020-21)	84.63 (15.87)	84.63 (16.34)	0.00
Sample size	329	1163	

Source: District administrative data

D4I. District C PSAT math sample

Note: Imbalances in the samples in tables D4I-D4L primarily result from weighting students in grade 9 separately from students in grade 10, and then aggregating the two samples. The subsequent regression analysis accounts for this by including controls for both student grade and the interaction between student grade level and prior math standardized test scores.

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
NWEA Math, Spring 2019	216.97 (11.93)	219.66 (15.03)	-0.18
State standardized test in math 2018-19	706.68 (21.96)	709.59 (25.22)	-0.12
NWEA English Language Arts, Spring 2019	211.2 (12.44)	213.38 (14.34)	-0.15
Math grade (2020-21)			
A or B	34.66 (47.61)	33.11 (47.06)	0.03
C	30.31 (45.98)	31.03 (46.26)	-0.02
D or F	35.03 (47.73)	35.86 (47.96)	-0.02
Failed a previous math class	13.99 (34.71)	11.85 (32.33)	0.07
Previously took an honors math class (2018/19 or 2020-21)	0.09 (3.04)	1.87 (13.54)	-0.14
Attendance (2018-19)	94.97 (4.61)	95.12 (4.65)	-0.03
Attendance (2020-21)	88.27 (16)	84.12 (19.28)	0.22
Sample size	1079	11574	

D4J. District C math grade sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
NWEA Math, Spring 2019	216.9 (12.03)	219.34 (15.39)	-0.16
State standardized test in math 2018-19	706.35 (21.92)	708.94 (25.99)	-0.10
NWEA English Language Arts, Spring 2019	211.26 (12.34)	213.39 (14.72)	-0.15
Math grade (2020-21)			
A or B	32.79 (46.96)	31.77 (46.56)	0.02
C	30.02 (45.86)	29.54 (45.63)	0.01
D or F	37.18 (48.35)	38.68 (48.7)	-0.03
Failed a previous math class	14.97 (35.69)	12.74 (33.35)	0.07
Previously took an honors math class (2018/19 or 2020-21)	0.08 (2.85)	1.23 (11.02)	-0.11
Attendance (2018-19)	94.67 (4.88)	94.57 (5.33)	0.02
Attendance (2020-21)	86.55 (17.6)	81.88 (21.78)	0.22
Sample size	1229	12594	

D4K. District C GPA sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
NWEA Math, Spring 2019	216.87 (12)	219.34 (15.16)	-0.17
State standardized test in math 2018-19	706.19 (21.93)	709.08 (25.55)	-0.11
NWEA English Language Arts, Spring 2019	211.21 (12.36)	213.35 (14.52)	-0.15
Math grade (2020-21)			
A or B	32.58 (46.89)	31.41 (46.42)	0.03
C	30 (45.84)	30.34 (45.97)	-0.01
D or F	37.42 (48.41)	38.26 (48.6)	-0.02
Failed a previous math class	15 (35.72)	12.7 (33.29)	0.07
Previously took an honors math class (2018/19 or 2020-21)	0.08 (2.84)	1.73 (13.05)	-0.13
Attendance (2018-19)	94.66 (4.9)	94.65 (5.35)	0.00
Attendance (2020-21)	86.51 (17.59)	81.82 (21.52)	0.22
Sample size	1240	12830	

D4L. District C attendance sample

Outcome	Saga mean (SD)	Comparison mean (SD)	Effect size
NWEA Math, Spring 2019	216.87 (12)	219.33 (15.16)	-0.17
State standardized test in math 2018-19	706.19 (21.93)	709.07 (25.55)	-0.11
NWEA English Language Arts, Spring 2019	211.21 (12.36)	213.34 (14.52)	-0.15
Math grade (2020-21)			
A or B	32.58 (46.89)	31.42 (46.42)	0.03
C	30 (45.84)	30.31 (45.96)	-0.01
D or F	37.42 (48.41)	38.27 (48.61)	-0.02
Failed a previous math class	15 (35.72)	12.73 (33.33)	0.07
Previously took an honors math class (2018/19 or 2020-21)	0.08 (2.84)	1.73 (13.04)	-0.13
Attendance (2018-19)	94.66 (4.9)	94.65 (5.36)	0.00
Attendance (2020-21)	86.51 (17.59)	81.82 (21.52)	0.22
Sample size	1240	12831	

Table D5. School-level impacts and student-tutor ratio

School	Type of blended model	Number of Saga students in standardized test analysis	Standardized test impact (SD units)	Math grade impact (SD units)	Average student-tutor ratio
District A			**Algebra/Geometry EOC exam (combined)**	**0.00**	
School 1	Online	89	-0.13	0.50	1.9
School 2	Online	61	0.10	-0.30	1.3
School 3	Online	131	0.18	0.49	1.7
School 4	Online	96	0.10	-0.08	2.5
School 5	Online	65	0.26	-0.33	2.0
School 6	Online	57	-0.25	-0.33	1.7
District B			**Algebra EOC exam**		
School 1	Hybrid	85	0.18	0.20	2.3
School 2	Online	48	0.64	0.58	1.2
School 3	Online	15	0.18	-0.12	0.8
District C			**PSAT Math**		
School 1	Hybrid	68	0.15	0.07	2.6
School 2	Hybrid	74	0.01	0.4	2.4
School 3	Hybrid	97	-0.15	-0.1	2.7
School 4	In-person	80	-0.21	0.1	2.9
School 5	In-person	15	0.16	-0.1	1.1
School 6	In-person	61	-0.09	0.4	1.9
School 7	In-person	21	-0.39	-0.4	2.6
School 8	In-person	111	-0.02	0.0	2.8
School 9	In-person	60	-0.24	-0.1	2.4
School 10	In-person	75	0.09	0.5	2.2
School 11	In-person	23	-0.14	0.1	3.2
School 12	In-person	35	0.16	0.3	1.9
School 13	In-person	69	0.05	-0.1	3.2
School 14	In-person	52	0.22	0.5	2.0
School 15	In-person	43	0.16	0.1	1.6
School 16	In-person	87	0.08	0.1	1.9
School 17	In-person	94	0.10	-0.1	2.5
Correlation with standardized test					-0.49
Correlation with math grade impact					-0.10

Source: District administrative data and Saga program data