CIGNITION IMPLEMENTATION

DENVER PUBLIC SCHOOLS

Grades: 3 - 9
Program Length: 10 Months
Treatment Year: 2022-2023

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1.0 — Introduction

1.1 — Background

Denver Public Schools (DPS) is located in Denver, CO and serves 89,213 students across 207 schools. DPS is a diverse system, with 36.3% of the student population classified as English Language Learners (ECE+). 36.4% of the students are Spanish-speaking, but other major languages spoken are Arabic, Vietnamese, Amharic, Somali, French, Nepali, Chinese, Mandarin, Russian, and Tigrigna.

This is the third year that Cignition has partnered with DPS to provide math tutoring to selected students. A pilot program launched in the Spring of 2020-21 and full programs were conducted in 2021-22 and 2022-23 with over 1000 participants in each year.

The graph in Figure 1 illustrates the learning loss students suffered during the Pandemic. Cignition's program was designed to help students address this loss.

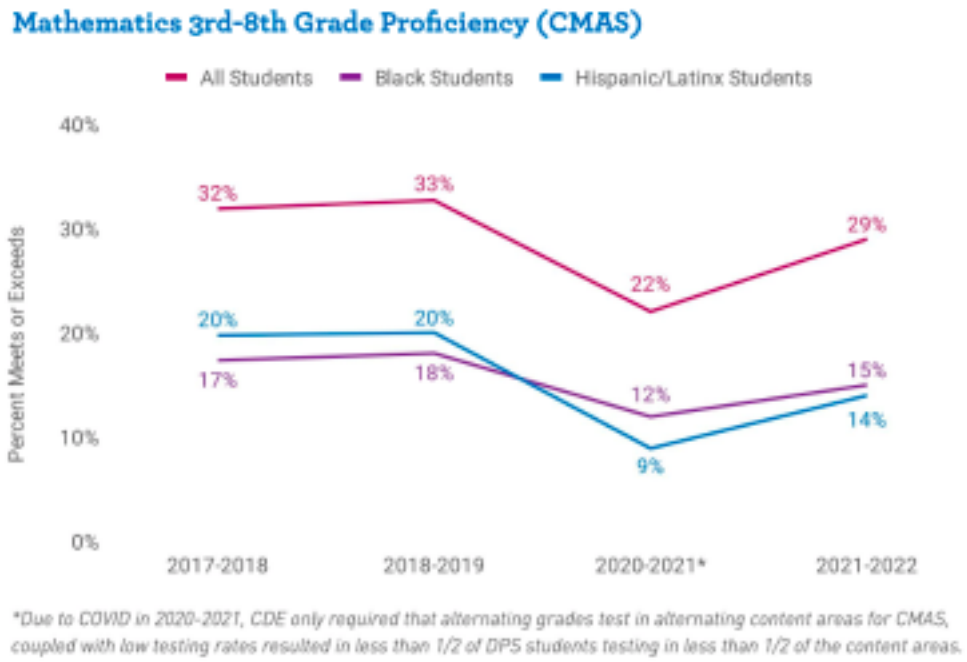


Fig. 1

In identifying participants, we focused specifically on targeting students most adversely affected by the pandemic, students of color, ELL students, and SPED.

Schools were targeted for participation based on 5 major equity metrics: schools with an ELL population of 25% or greater, a Homelessness population at 10% or greater, FRL students at 25% or greater, SPED students at 10% or greater and then a focus on specific Ethnicity groups, African American population at 15% or greater, and Hispanic population at 25% or greater. Schools were ranked by meeting each of the 5 criteria, with priority given to schools meeting all 5 and working down from there.

1.2 — Program Description

Tutoring sessions were designed to meet in a consistent cadence (same times and days of the week) during the school day to create a structure for the students to increase attendance and engagement. The goal was a 4:1 student to tutor ratio to facilitate a collaborative learning environment. Due to logistical constraints, we ended up with a 3.6:1 actual ratio. Each session lasted from 25 to 60 minutes, and sessions were held 2 to 5 times per week, depending on the local implementation of the program. Tutoring was offered in 21 schools across the district, with 1044 students enrolled across 125 classes and 281 individual groups.

Weekly meetings with leadership from each school allowed us to review current data, enabling us to address issues that impact tutoring effectiveness and inform instruction. 95% of our schools attended check-ins and used them to align instruction in sessions with the classroom.

2.0 — Data Collection

2.1 — Introduction

Data was collected in two different main categories: student engagement and academic progress. It was collected through automated processes, tutor input, and student feedback. District leadership and school personnel were given on-demand access to all data through our teacher portal. Reports were compiled, summarized, and presented weekly to district and school leadership.

2.2 — Engagement Metrics

Student engagement was measured using four key indicators: attendance percentage, engagement (as measured by the tutors at the end of each session,) contact hours, and a daily student survey.

Attendance

- Attendance percentage
    - Percent of scheduled sessions that a student attended
- On time/late
    - Percent of scheduled sessions that a student arrived in the first 5 minutes
- Contact hours
    - Total number of hours that a student was in session with a Cignition tutor and their group.

Tutor Feedback

- Measured on a five point Likert scale daily by the tutor
    - 0% of the session time
    - 25% of the session time
    - 50% of the session time
    - 75% of the session time
    - 100% of the session time
- Measured across three categories
    - Persevered with Tasks
    - Listened Actively to Peers and Tutor
    - Participated in Discussions
- Three category scores averaged for an overall “engagement” score
- Tutor comments
    - Narrative of each day's session that records student progress and misconceptions

Student Feedback

- Survey administered the last minute of each session
- Measured on a four point Likert scale
    - Strongly Agree
    - Somewhat Agree
    - Somewhat Disagree
    - Strongly Disagree
- 3rd and 4th grade students had a descriptive emoji added to the scale for clarity.
- Measured across four categories
    - My tutor talks to me about my work to help me understand my mistakes (Tutor Relationship)
    - I take turns, listen to, and work with others in my session (Collaborative Learning)
    - Right now, I understand more of what we covered than when we started (Conceptual Understanding)
    - I don't give up when the material is challenging (Productive Struggle/Growth Mindset)
- For the outcome based contract, questions were grouped into two categories
    - Identity (Tutor Relationship and Collaborative Learning)
    - Efficacy (Conceptual Understanding and Productive Struggle/Growth Mindset)

2.3 — Academic Progress Metrics

Student academic progress was measured through two methods: standards progress and a pre-diagnostic/post-diagnostic assessment series.

Standards Progress

- Measured daily by tutor in post-session notes
- Direct observation of student mastery by tutor
- Process of obtaining the answer is considered
- Measured with a three point Likert scale
    - Complete Understanding (1.0 point)
    - Partial Understanding (0.5 points)
    - No Understanding (0.0 points)
- Cignition's goal is conceptual mastery for students.
    - Therefore standards are generally addressed across multiple sessions.
    - The final session's score is the "Standards Mastery" score for that student

Diagnostic Assessment Series

- Given at the beginning and end of a semester.
- Questions reflect the key standards that students will address that semester
- Due to school logistics, assessments were generally not given before instruction had already started in the classrooms (did not align with the beginning of semesters).
- Due to student absences and school functions, 30.6% of enrolled students failed to complete a series.
- Progress was measured using absolute gain, the difference between the percent correct on the post-diagnostic and percent correct on the pre-diagnostic.

3.0 — Data Analysis

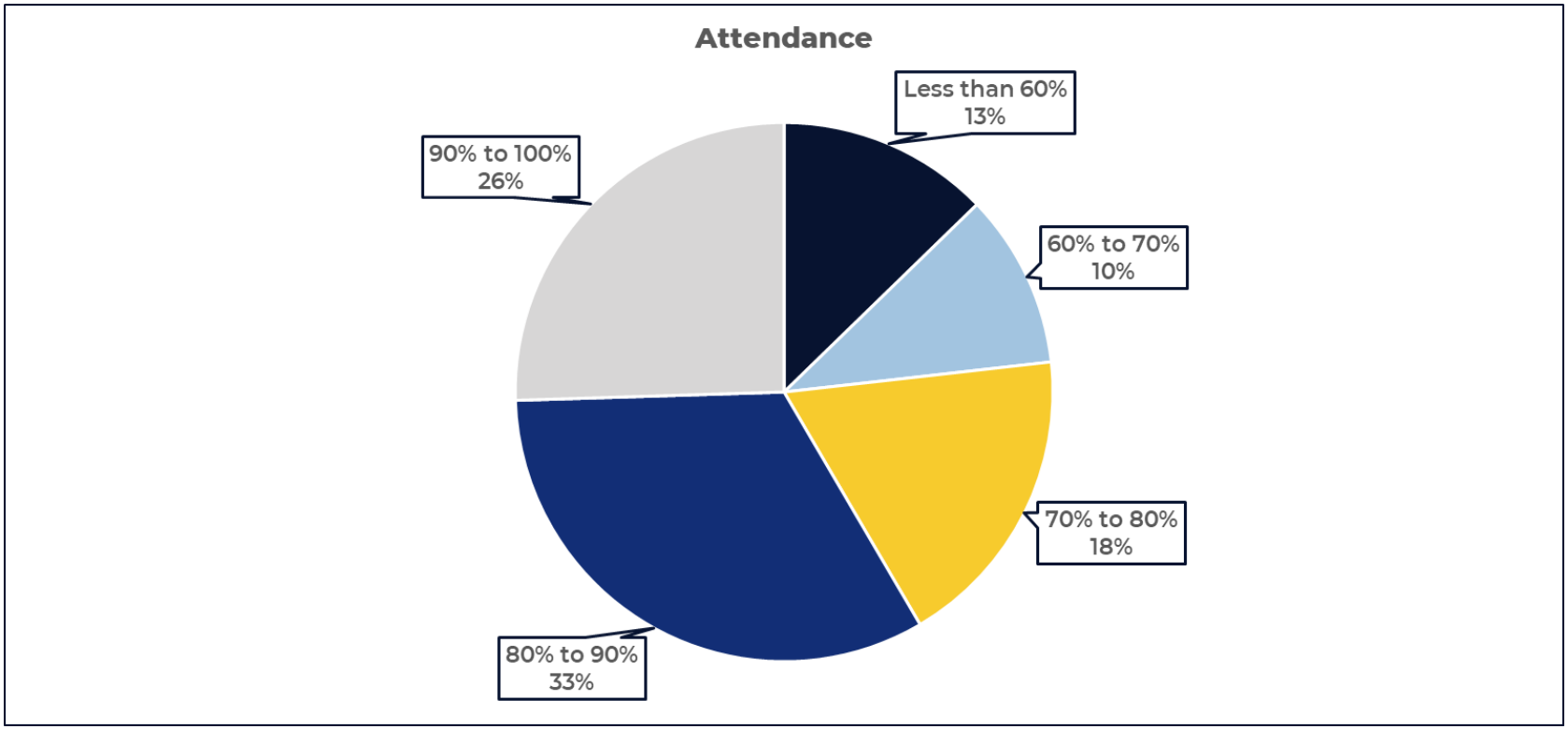
In order to ascertain the health of the program, we measured four main categories. We theorized that students who attended at least 70% of the scheduled sessions, scored 80% or higher on their engagement score, attended 25 hours or more per semester, and gave 90% or higher positive ratings on their student survey questions would make more academic progress. We set these standards as goals, and used them to measure student engagement weekly and make adjustments to our program to increase engagement. Since we were in our second year of full implementation at DPS, we measured each metric against last year's results to determine if our adjustments were improving engagement.

In order to ascertain the effectiveness of the program, we examined the relationship between engagement and student progress. Our hypothesis was that more engaged students would show greater academic progress.

3.1 — Student Engagement Metrics

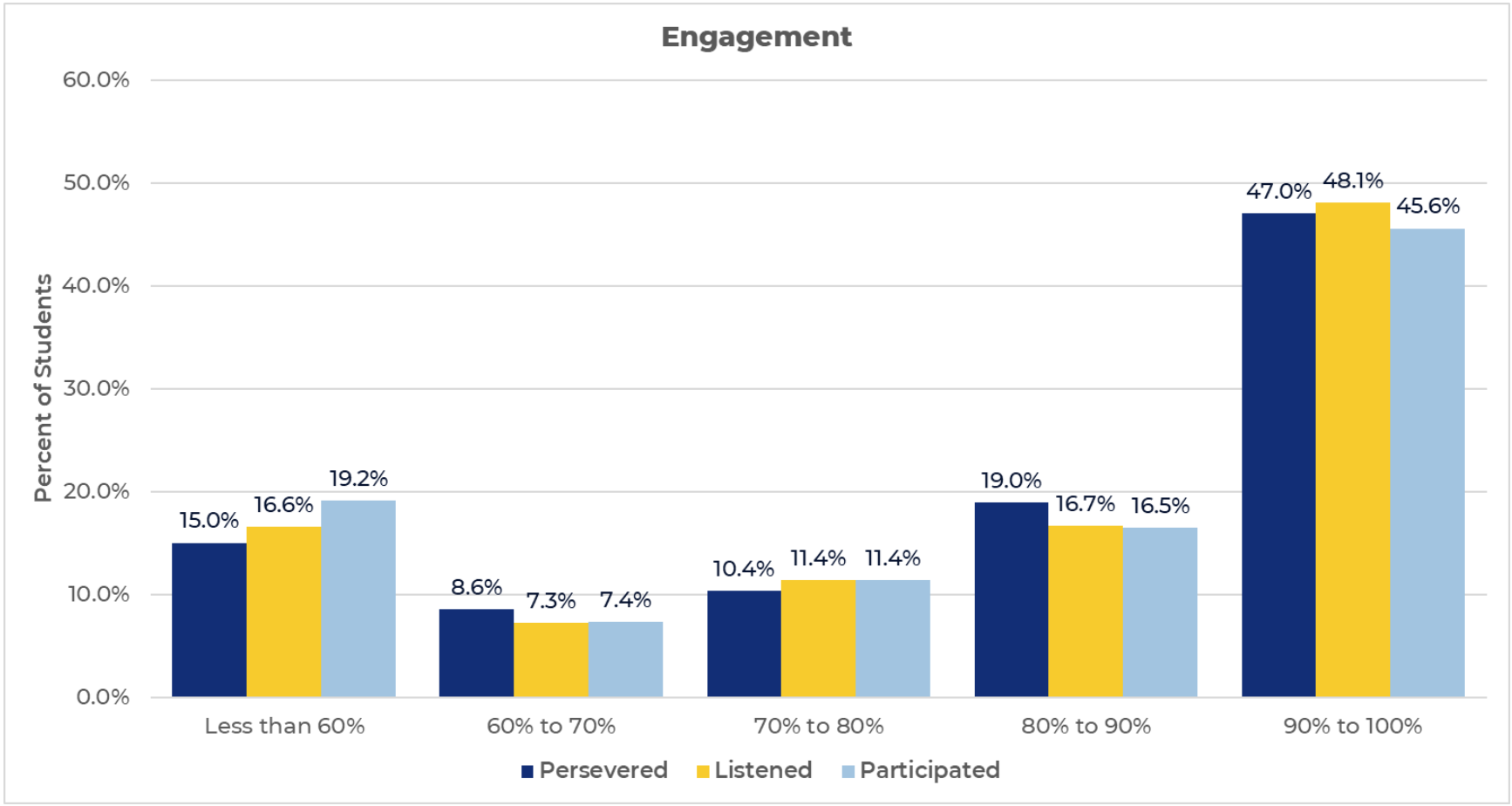
3.1.1 — Attendance

The average student attendance was 77.5% across all scheduled sessions. 78.5% of students who had 5 or more contact hours (in other words, did not exit the program early) met the attendance standard of 70%.



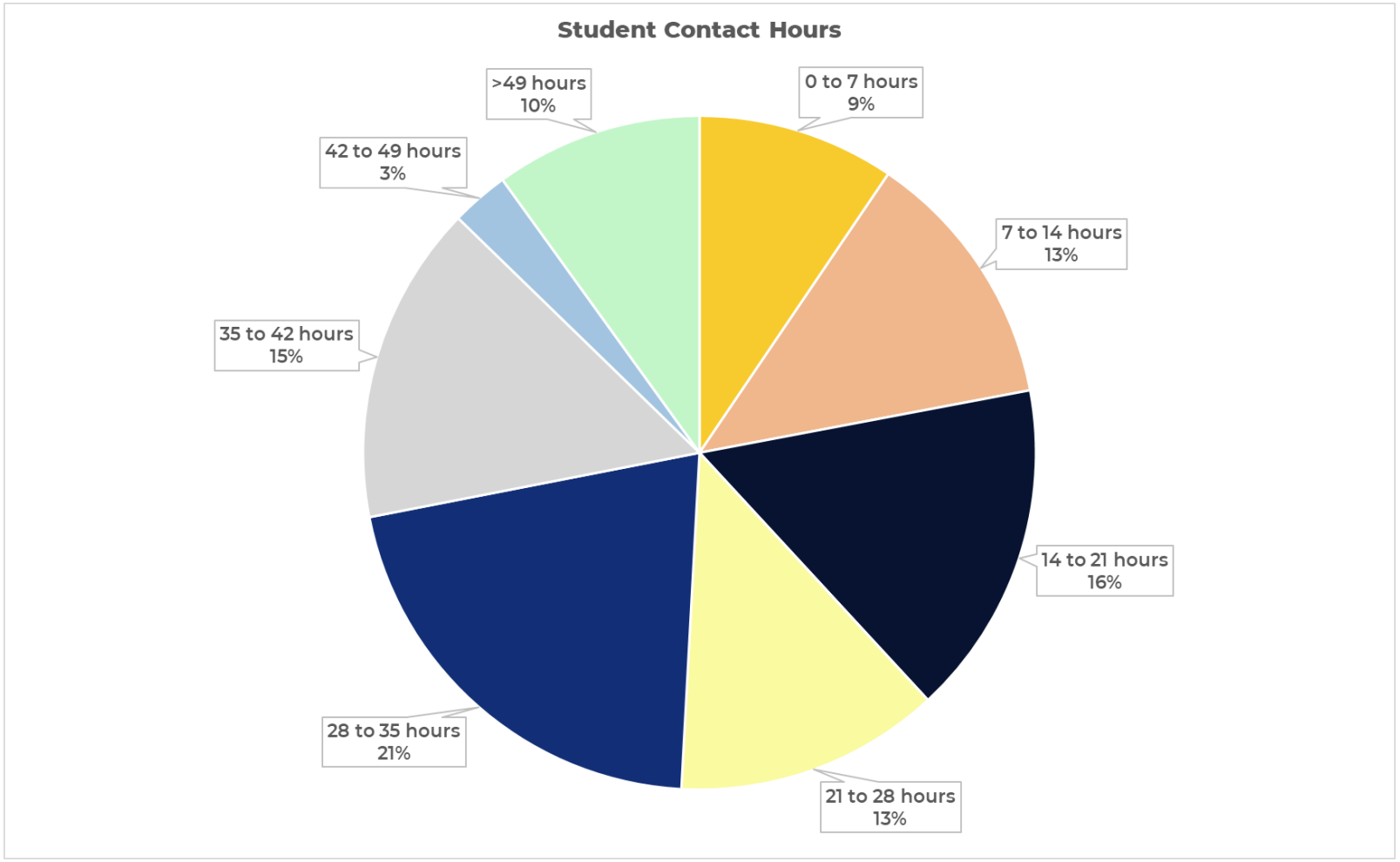
3.1.2 — Engagement

The average student engagement was 82.3% across all scheduled sessions. 64.9% of students who had 5 or more contact hours met the engagement standard of 80%.



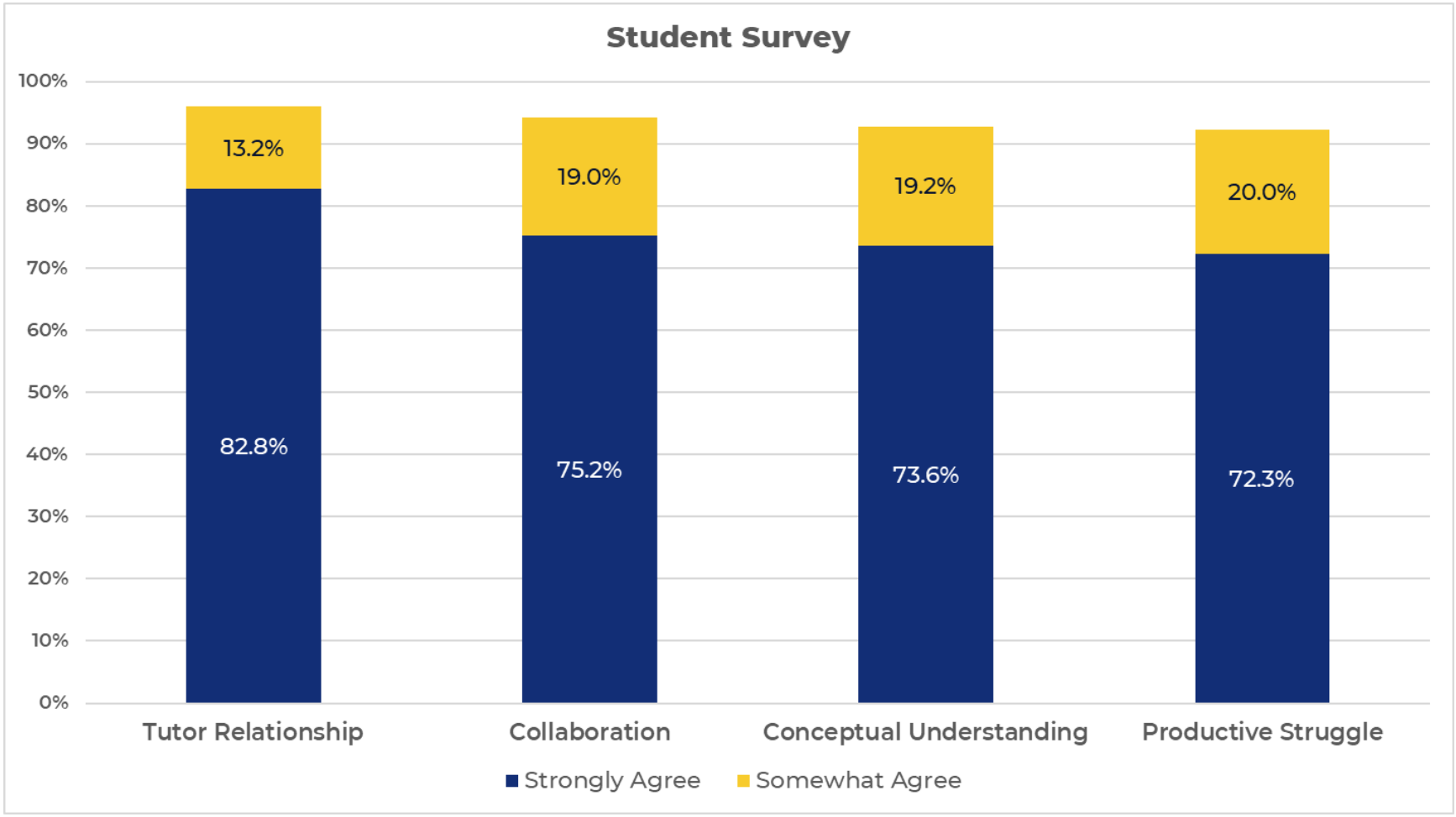
3.1.3 — Contact Hours

Our goal for contact hours was 50 for the entire school year, 25 per semester. This was taken into account in the initial program design. However, local logistics frequently delayed the start of programs and ended them early. The average student in the program had 27.8 instructional hours, with a median of 28 hours.



3.1.4 — Student Survey

Our goal for student survey results was for each student to respond positively (either “Strongly Agree” or “Somewhat Agree”) 90% of the time as an average across the four questions presented. The overall average for Denver students was 95.0%. 89.7% of students met the standard.



3.1.5 — 2021-22 vs. 2022-23

This was our second year with a full implementation at DPS. We used a comparison between the previous year's metrics as a measurement of progress during the year, helping us make data-driven decisions about adjustments we would need to make. The comparisons helped us communicate more effectively with schools, anticipate and adjust for scheduling issues, and respond to student challenges more readily.

Denver Outcome Based Contract Data	2021-2022	2022-2023
Attendance	64.2%	77.5%
Engagement	74.2%	82.3%
% students improving on 10+ standards	31.0%	47.0%
Growth on Diagnostic Series	64.6%	72.7%
Diagnostic Series Growth >=10%	47.9%	55.4%
Diagnostic Series Growth 5%<x<10%	15.2%	16.8%

3.2 — Student Progress Metrics

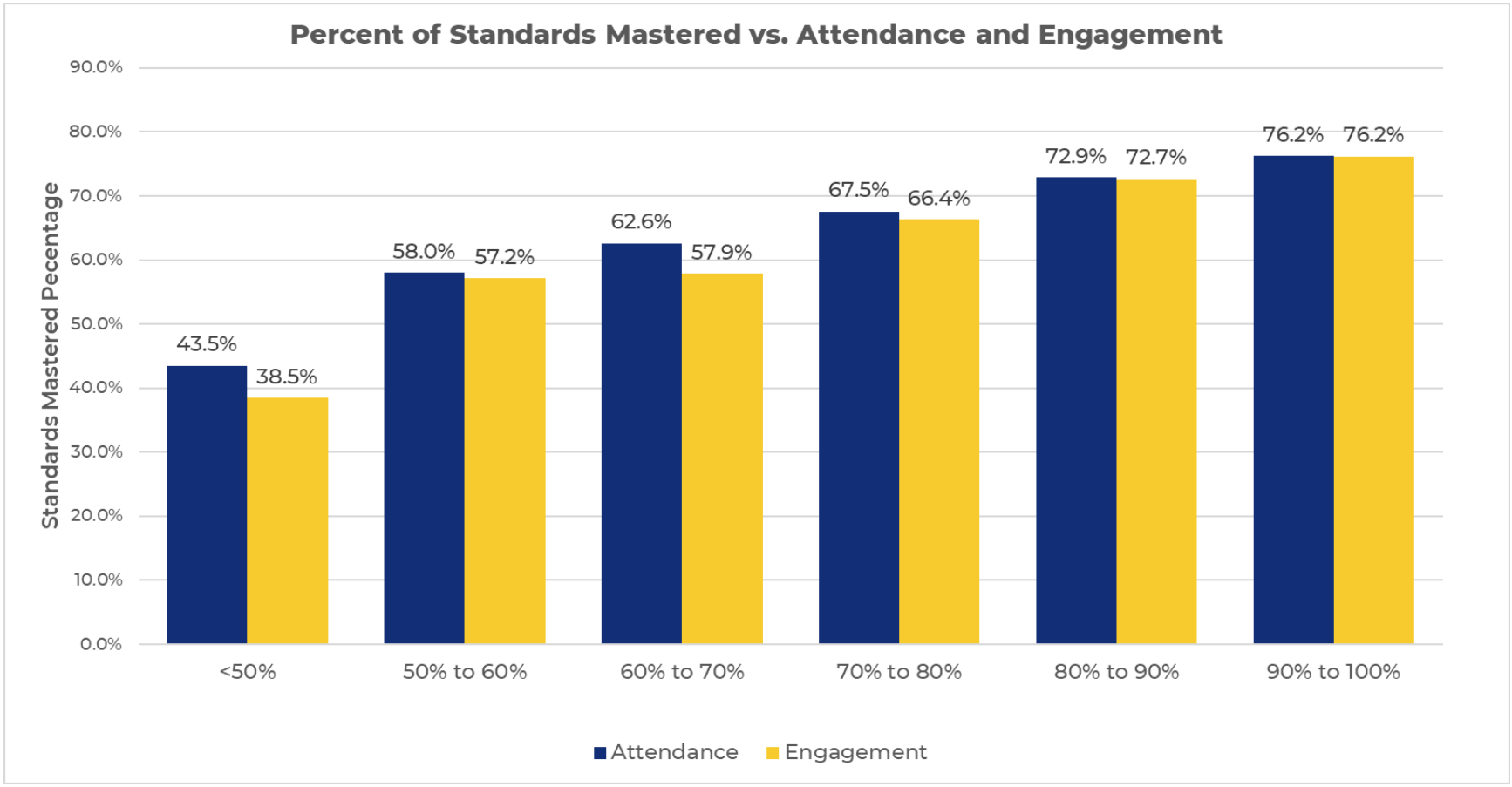
The value of any educational program is determined by the answer to the question, “Does it work?” While there is a lot of debate about the best way to measure student progress, we used two different tools for our program. First, we measure a metric called “Standards Progress” at the end of each session. Tutors use direct observation of student work to determine if the student has mastered the standard. The process of obtaining the answer is taken into account when assessing the student. Tutors can assign one of three outcomes for each standard: “Complete Understanding,” “Partial Understanding,” and “No Understanding.” A fourth outcome is also available, “Not Assessed” for sessions where the students were not asked to demonstrate their mastery in a session. (Standards Progress is a rough measure of the percentage of standards engaged that a student mastered. For example, if a student mastered every standard that they engaged, their Standards Progress score would be 100%. If they demonstrated partial understanding on every standard engaged, the Standards Progress score would be 50%. No understanding demonstrated on each standard would yield a 0% score.) Cignition’s goal is for students to move from “No Understanding” to “Complete Understanding” during the sessions that are focused on a particular standard. (Since our goal is student mastery, standards are often engaged for multiple sessions.) The score for a student is taken from their final session’s assessment. Second, we used a pre-diagnostic/post-diagnostic series that contained problems from the major standards that the students engaged during their time in the program. This is a multiple choice test that does not take into account the process of obtaining the answer.

3.2.1 — Standards Progress

The Standards Progress score does not have a baseline score to measure a differential between initial student understanding and final achievement. (However, there is an assumption that students have not mastered the standard.) Also, since Cignition focuses on mastery, groups engage a different number of standards. The following results measure the final student “Standards Progress” average against various measures of their engagement. Again, our hypothesis is that more engaged students would demonstrate higher academic achievement.

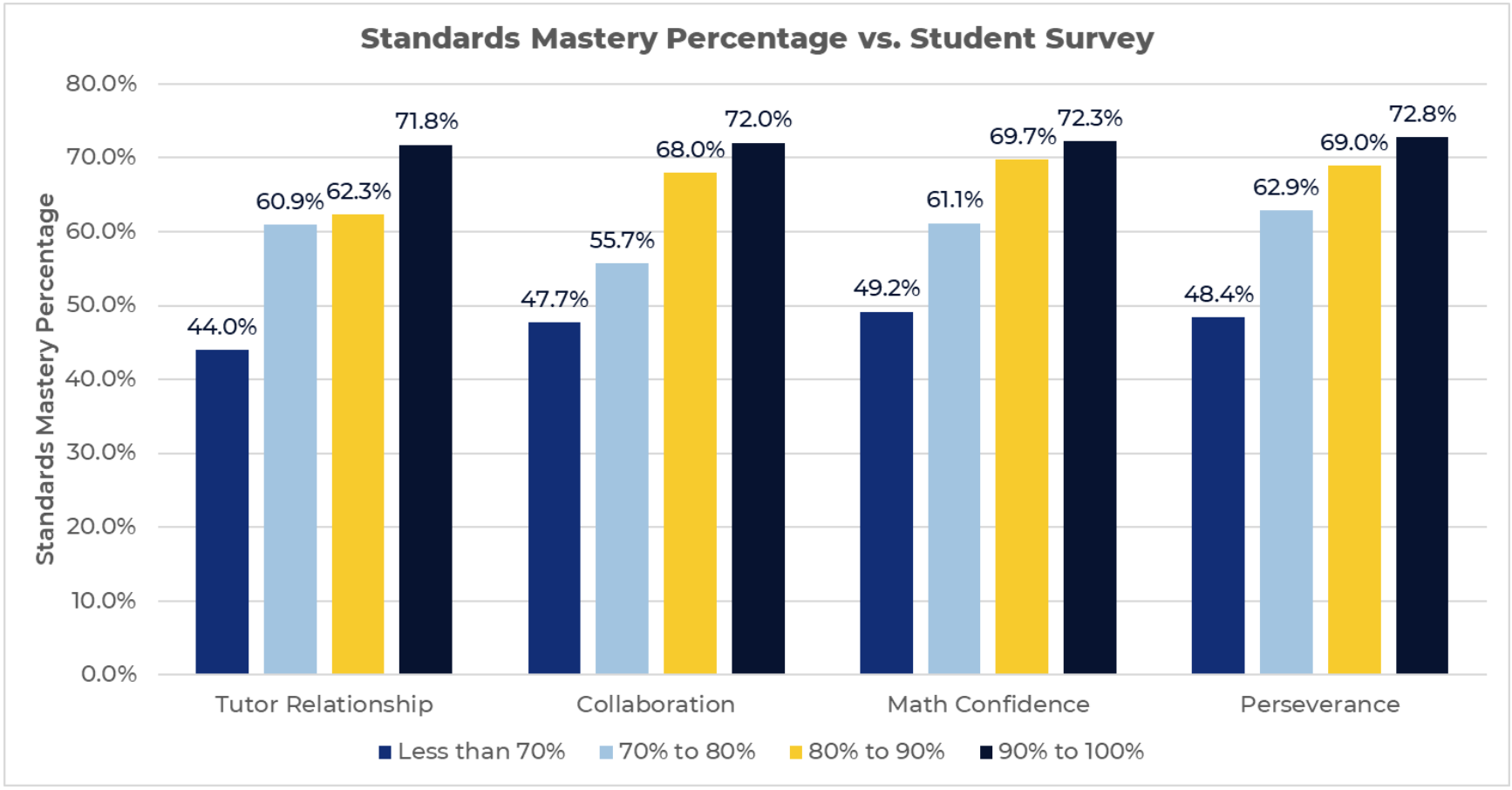
3.2.1.1 — Standards Progress vs. Attendance and Engagement

As expected, students demonstrated a higher average on their Standards Progress average as their attendance and engagement increased.



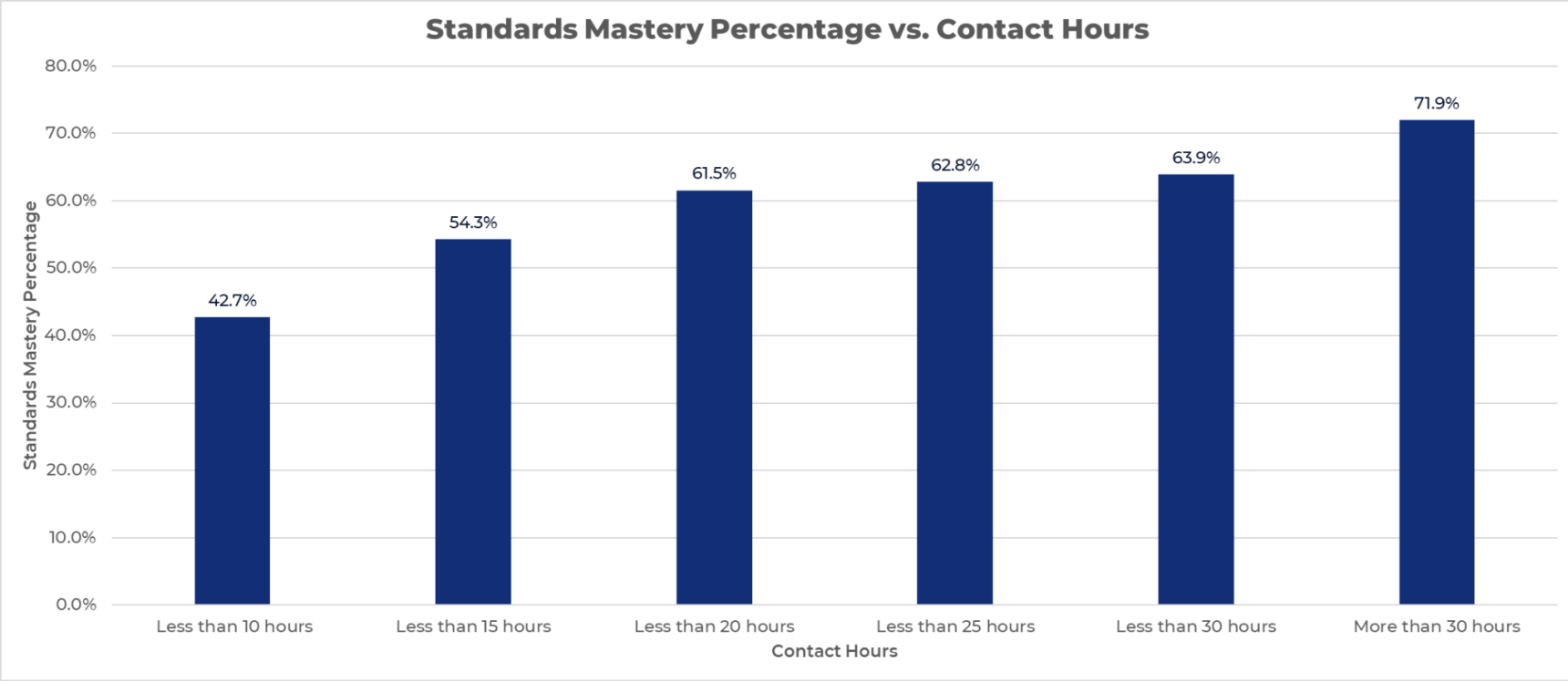
3.2.1.2 — Standards Progress vs. Student Survey

This graph demonstrates the effect of student perception on Standards Progress results. As students reported that they were more confident in their tutor relationship, collaborative skills, math confidence, and perseverance, their rate of standards mastery increased.



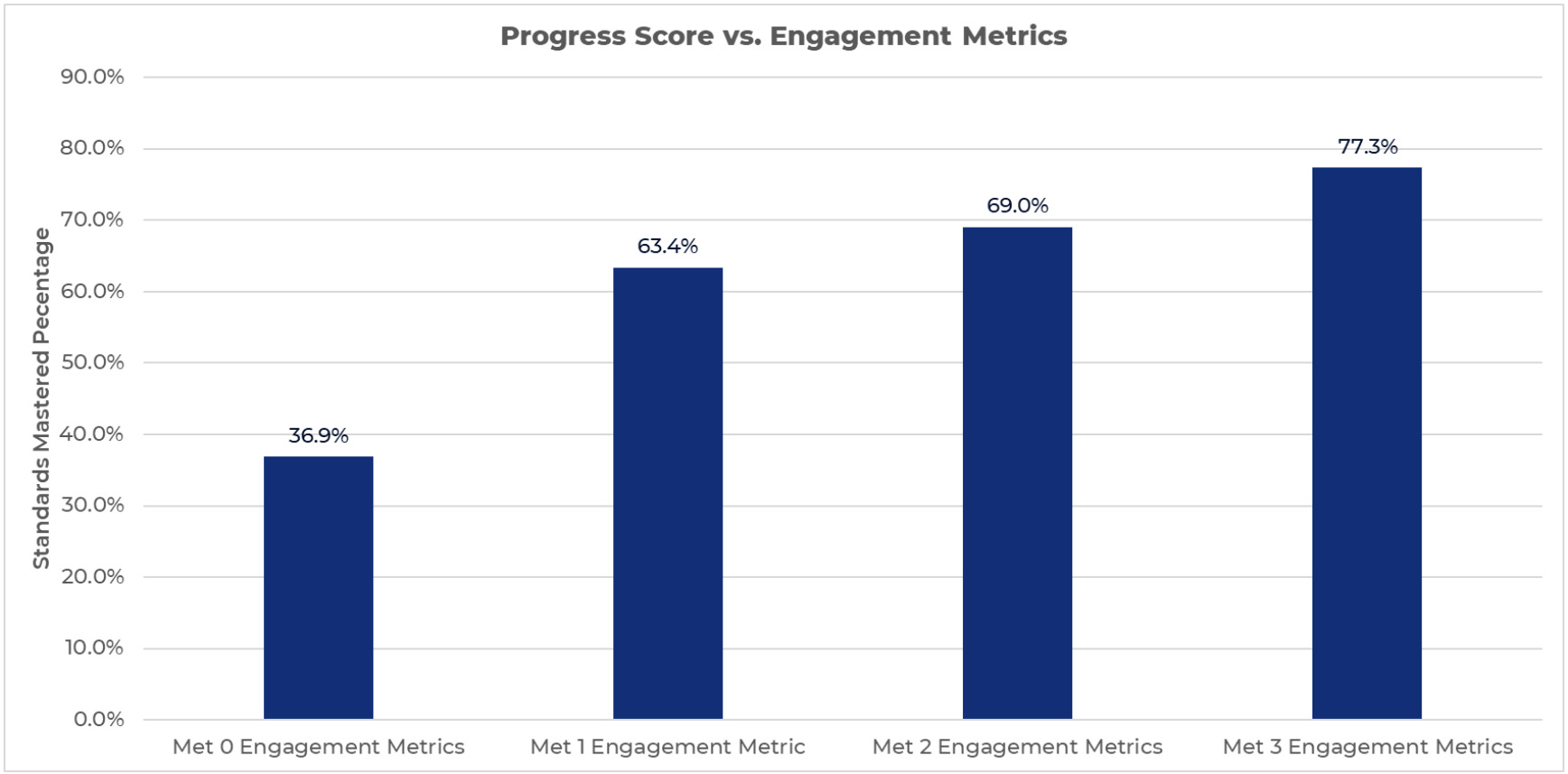
3.2.1.3 — Standards Progress vs. Contact Hours

Due to a variety of program designs as well as student attendance, DPS students had a range of contact hours in the program. Cignition focused on conceptual mastery using inquiry-based learning in a collaborative environment. For this measure of engagement, we anticipate that students will increase their Standards Progress average as they spend more time in the program. In effect, we expect that students will "learn how to learn" the more time they spend in the program environment. The graph below shows the increase in Standards Progress as students spent more time in the sessions.



3.2.1.4 — Standards Progress vs. Key Metrics

During the year, we focused our weekly meetings on our three key metrics: attendance, engagement, and contact hours. The assumption was that students who met all three standards would show greater academic achievement. The graph below shows the relationship between the number of key metrics that a student met (attendance 70% or greater, engagement 80% or greater, 25 or more contact hours) and the percentage of standards that they mastered.

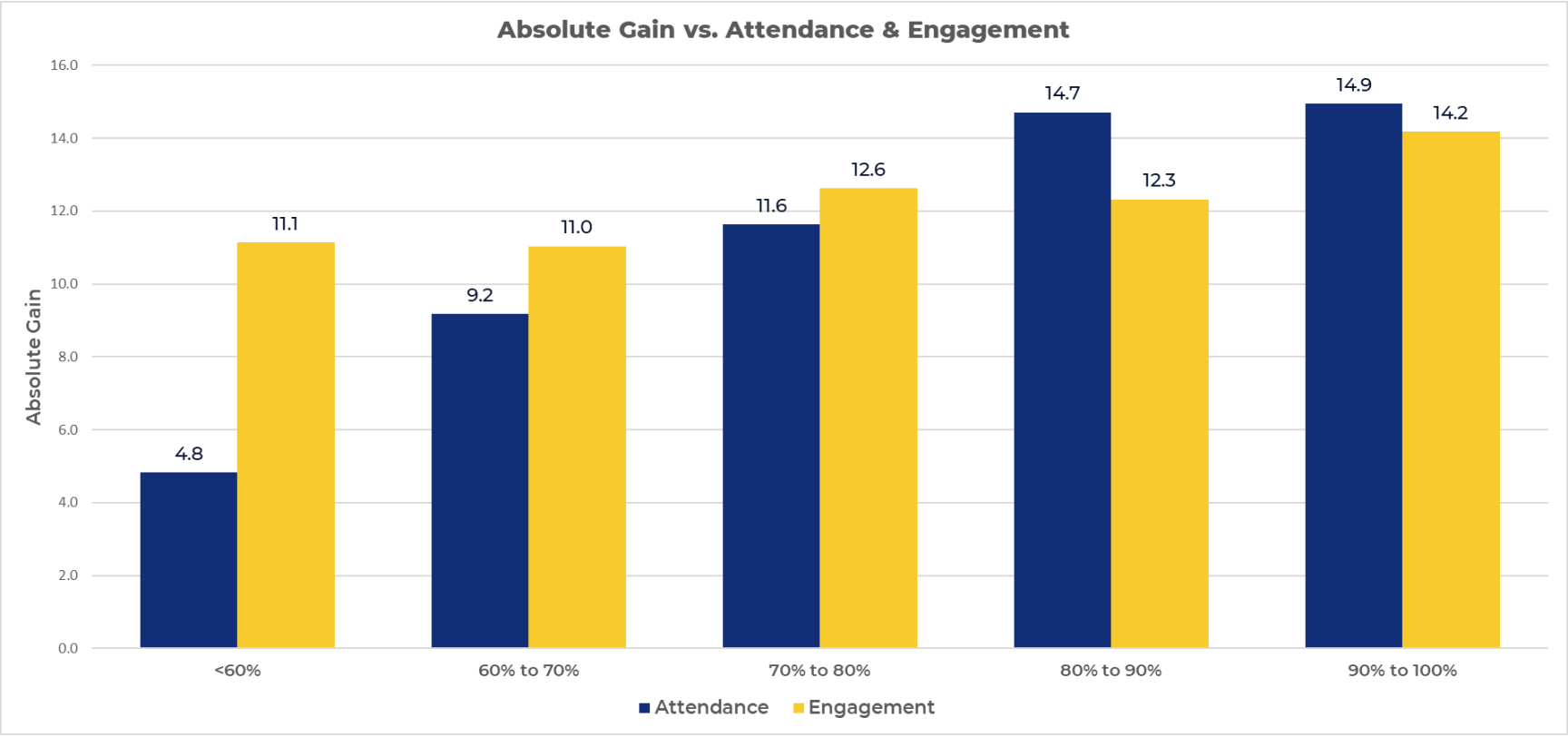


3.2.2 — Diagnostic Series

Each student in the Cignition/DPS program was administered a pre-diagnostic/post-diagnostic series at the beginning and end of the program. The questions are drawn from the key standards that the students are expected to engage with over the course of the sessions. It is a multiple choice test with 4 possible answers on each item. Due to program logistics and student attendance, not every student received a complete series. 84.5% of students who had 15 or more contact hours had a complete series. The score is the absolute gain from pre-diagnostic to post-diagnostic (post-diagnostic percentage minus the pre-diagnostic percentage.)

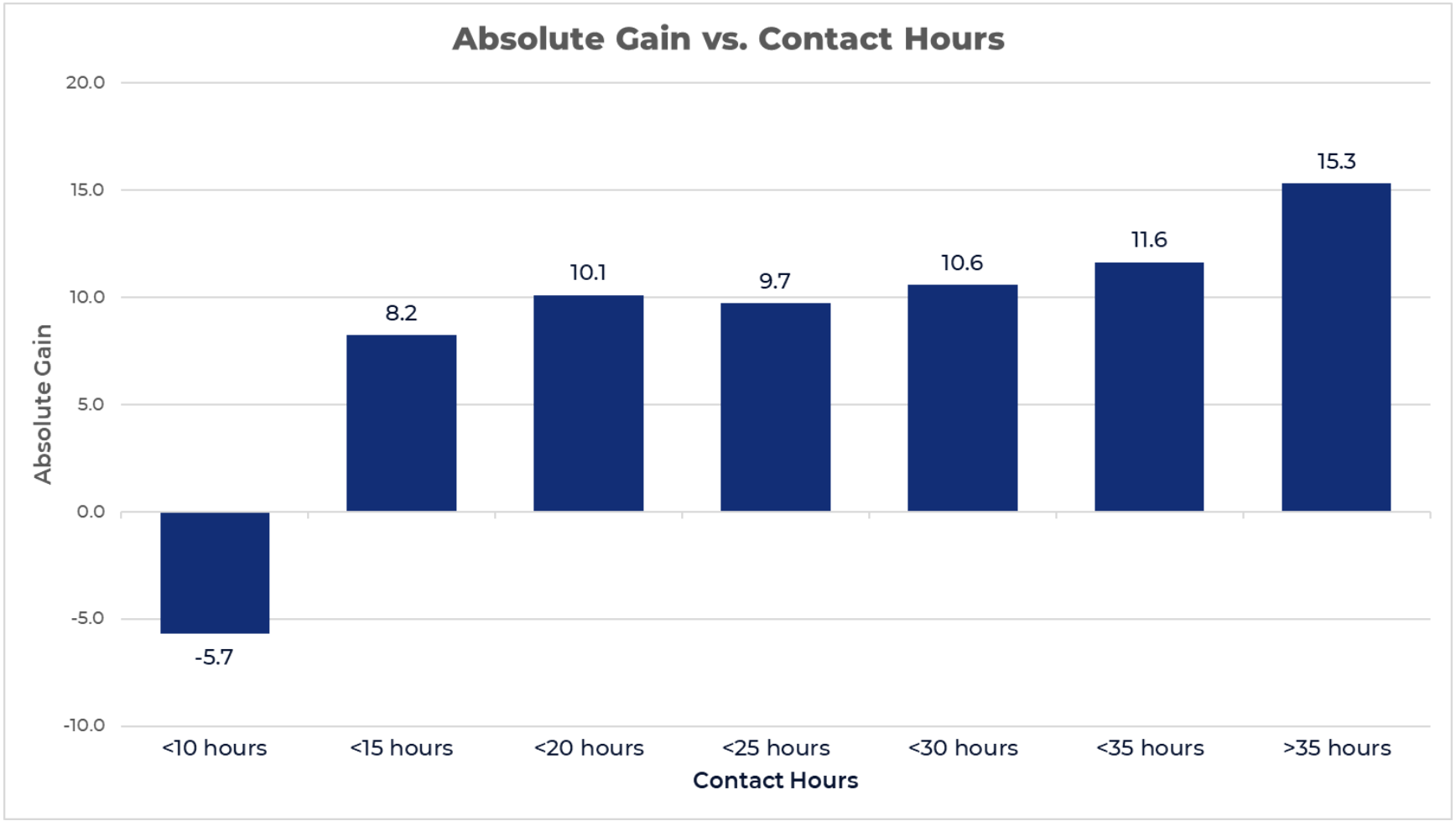
3.2.2.1 — Diagnostics vs. Attendance and Engagement

As expected, the scores show a relationship between Absolute Gain and Attendance. The relationship between Absolute Gain and Engagement is visible, but weaker. The data for students with engagement of less than 60% is skewed by a few outliers who had an absolute gain of 25 points or more. However, those students attended 9.1% more than the average student (88.6%) and had 14.5 more contact hours than the average student (42.3 hours) which are two other key metrics for engagement.



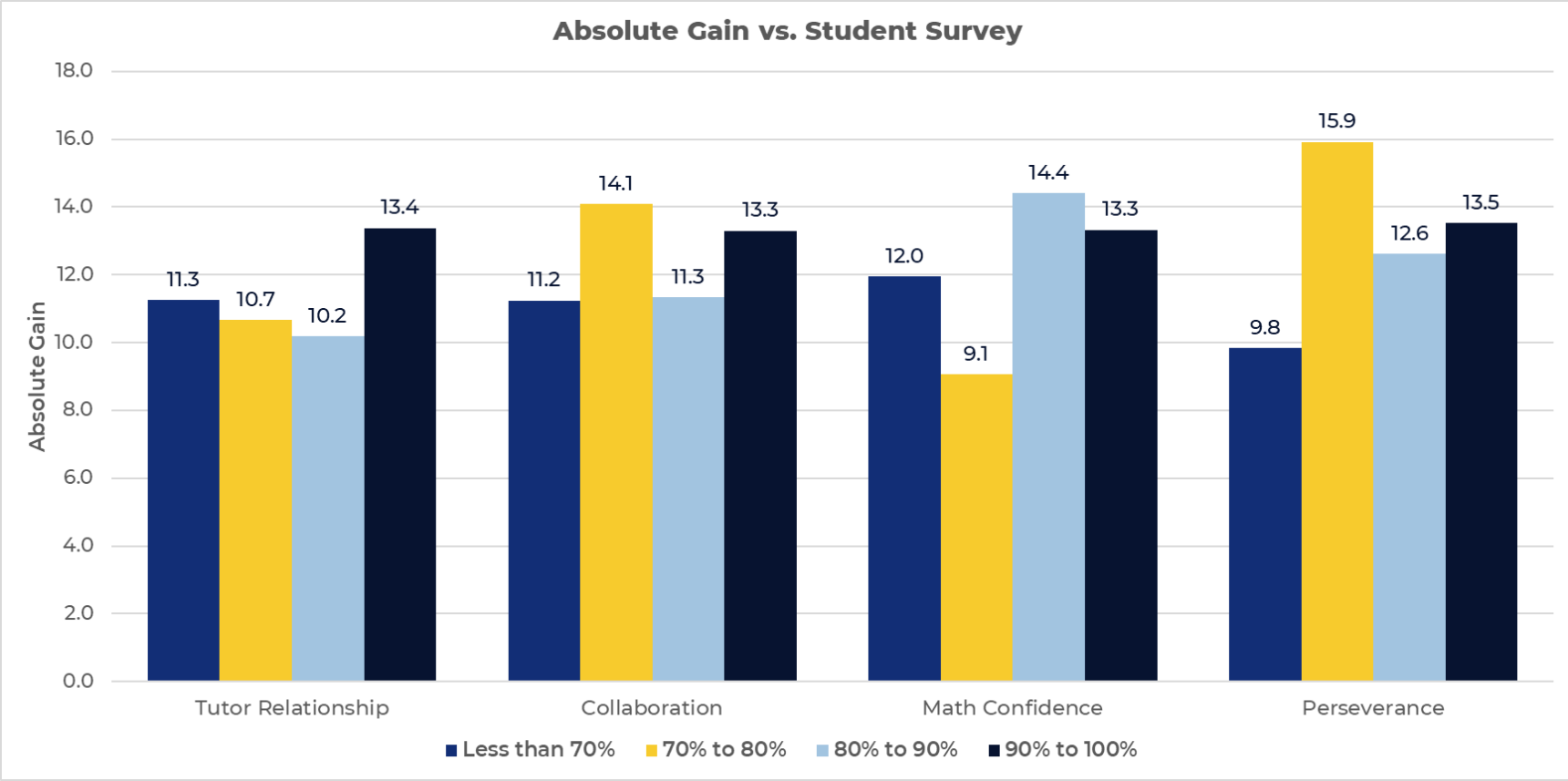
3.2.2.2 — Diagnostics vs. Contact Hours

The scores show a relationship between contact hours and academic achievement, especially at the extremes. The relationship is not as clear in the middle of the curve. However, once students reach our goal of 25 instructional hours, student outcomes improve.



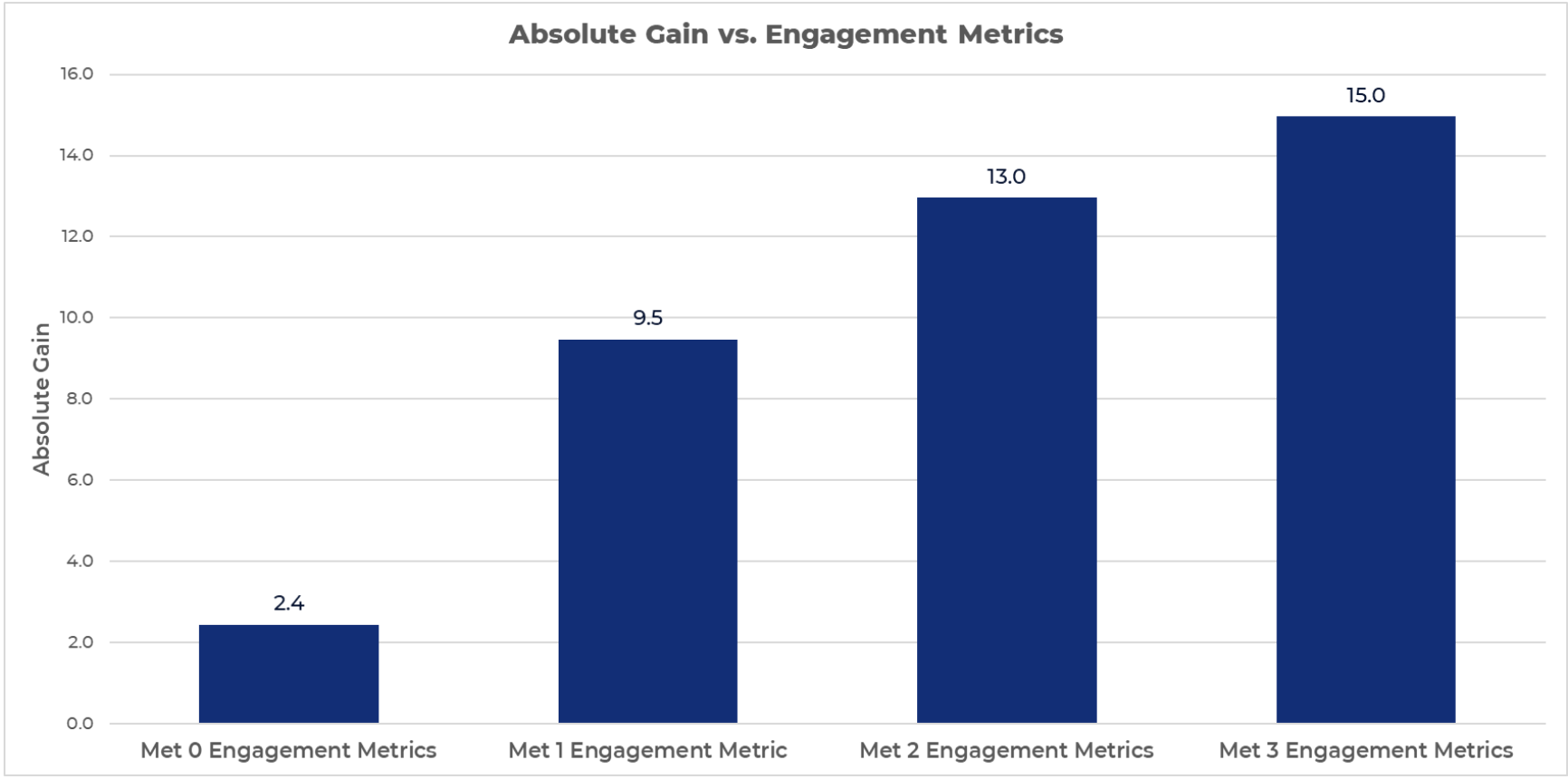
3.2.2.3 — Diagnostics vs. Student Survey

Student survey data is too affected by the small n-values of the categories below 90% to show a relationship. 75% (Perseverance) to 86% (Tutor Relationship) of students who have a complete diagnostic series reported 90% or greater positive responses for each question. What is clear is that students who were confident in all the categories exceeded our goal of 10% absolute gain.



3.2.2.4 — Diagnostics vs. Key Metrics

This graph illustrates the effect of the three key metrics: attendance, engagement, and contact hours on diagnostic outcomes. The assumption was that students who met all three standards would show greater academic achievement. The graph below shows the relationship between the number of key metrics that a student met (attendance 70% or greater, engagement 80% or greater, 25 or more contact hours) and their absolute gain on the diagnostic series.



4.0 — Findings Summary

Last year, we saw a strong relationship between students meeting the key engagement metrics and their academic performance. In both of our measures of academic achievement (Standards Progress and Diagnostics series) we again saw this illustrated: The more students are in session, engaged, and given time to learn, the better their outcomes. Of course, this is no surprise. The human brain is a learning machine, and when engaged with excellent teachers and well-developed curricula, learning results. Our outcomes confirm our hypothesis across both measures of student achievement.

However, a deeper lesson can be drawn from this year's data. Since this was Cignition's second full year working in partnership with DPS, we were able to compare the key engagement metrics for 2021-22 against those of 2022-23 in real time. We were able to use that data to make adjustments in the program and individual student's environment. The result was that we improved in every area.

Why does this matter? We know from the data that increased engagement leads to better academic outcomes. While we continue to improve our tutor training and curricula to help students learn more effectively, we learned this year at DPS that consistency over time matters. We are able to make adjustments that improve the engagement metrics. Increased engagement metrics lead to better student achievement. By improving program design and implementation, we are able to help students learn math more effectively.