The Impact of Parent Engagement on Student Outcomes: Analysis of the FUEL Education Model

(*Currently Inversant*)

Bridget Terry Long, Ph.D.
Saris Professor of Education and Economics
Harvard Graduate School of Education

February 2016

SUMMARY

Although there have been numerous descriptive studies that relate higher levels of parental involvement to better student academic performance, little research has been done to document whether increasing parental involvement has a direct, positive impact on student academic performance and behavior. In this report, I continue the analysis started earlier to examine the effects of parental involvement in FUEL on the student outcomes up until 2013-14. This research is guided by the core question: what is the impact of increasing parental involvement in the college access process on student's academic achievement and behavior?

To gauge the effects of FUEL, I investigate a range of outcomes using administrative student records and transcript data from the Chelsea School District. These data sources give valuable information on high school course performance, test scores, attendance, and future college plans. To give a sense of the outcomes students would have experienced if they had not had FUEL, I compare the outcomes of FUEL students to those of other students, though I remain concerned that many of the results in this report are influenced by the fact that students whose parents participate in FUEL are generally higher achievers even before receiving any FUEL services.

Both the descriptive results and regression analysis suggest that FUEL students do better on exams and have higher high school grades in key subjects. There is even suggestive evidence that that grade performance gap increases over time, from 9th to 11th or 12th grade, which might be partly attributable to participating in and benefitting from FUEL. FUEL students also seem to be more likely to take math and science classes as high school juniors and seniors, which could indicate a higher likelihood of preparing academically for college. Attendance levels are also much higher for FUEL students. Finally, student plans at graduation, as measured by a self-reported survey, suggest that FUEL students are much more likely to enroll at a four-year college than non-FUEL students. The difference is resounding and is suggestive of the positive benefits of FUEL.

However, these results are not causal and may partly be driven by the fact that FUEL students are different from non-FUEL students in terms of observable characteristics and most likely also in terms of unobservable characteristics (i.e., things not easily measured in school records, such as motivation and perseverance). Therefore, while the patterns evident in the data are quite complimentary of FUEL, the limitations of the research design and data do not allow for more definitive conclusions about the magnitude of the *causal* effect of FUEL.

I. INTRODUCTION

Although there have been numerous descriptive studies that relate higher levels of parental involvement to better student academic performance, little research has been done to document whether increasing parental involvement has a direct, positive impact on student academic performance and behavior. In this report, I continue the analysis started earlier to examine the effects of parental involvement in FUEL on the student outcomes.[1]

The first year of the project focused on collecting survey data from the families and students in FUEL during 2012-13. In addition to summary reports on the backgrounds and experiences of families in FUEL that year, we also applied for research approval and finalized data exchange logistics with the Chelsea and Lowell School Districts. During the second year of the project, we received administrative student data for the 2012-13 school year. I used those data to conduct early analyses on the impact of FUEL on student outcomes, and these results were used in presentations at the National College Access Network (NCAN) Annual Conference and FUEL Board Meeting. This report integrates an additional year of data into the analysis to increase the sample size and hopefully improve the chance of finding statistically significant of the results. An additional year of data also enables me to look at longer-term outcomes.[2]

This research is guided by the core question: what is the impact of increasing parental involvement in the college access process on student's academic achievement and behavior? To gauge the effects of FUEL, I investigate a range of outcomes using administrative student records and transcript data from the Chelsea School District. I have student background, MCAS scores, and attendance information from 2008-09 to 2013-14 and transcript data, which includes course selection and grades, for 2013-14. These data sources give valuable information on high school course performance, test scores, attendance, and future college plans.

While looking at the educational trajectories of students in FUEL provide interesting information on the academic well-being of participants, to truly understand whether FUEL has had an effect, one must try to get a sense of the counterfactual. Stated another way, I try to establish what would have happened to the students had their families not had access to the support and services of FUEL. I construct a couple of comparison groups and contrast the outcomes of FUEL students to those of other students. However, I remain concerned that many of the comparisons in this report are influenced by the fact that students whose parents participate in FUEL are generally higher achievers than other students *even before receiving any FUEL services*. Therefore, it remains difficult to discern the causal effects of FUEL from factors that may have already been a part of the families who choose to participate in the program. To preview the results, my analysis suggests Not only are families saving, but there also appears to be an effect on students' academic trajectories: they score higher on exams and have higher grades. They also have higher aspirations and are more likely to plan to attend college after graduation.

[1] In September 2015, FUEL Education changed its name to Inversant. However, because this analysis goes up to spring 2014, before the name change, I will continue to refer to the participants as being a part of FUEL.

[2] The original hope was that this report would have been completed in summer 2015. However, obtaining data from the Chelsea and Lowell Public School districts was slower than expected. When we did receive the data in September 2015, we discovered we were missing a portion of the students. Obtaining the full data became a lengthy process, which further delayed the completion of the analysis.

II. CHARACTERISTICS OF FUEL PARTICIPANTS

a. Who are the FUEL participants?

Table 1 presents summary information about the children of parents who participate in FUEL in the Chelsea School District. I display information about the cohort of students who were a part of FUEL before 2013-14 and 61 new students who joined FUEL in 2014. Additionally, based on information from the 2012-13 data files, I can identify 37 students whose families started to participate in FUEL but ended their involvement before the student graduated high school. The last column combines the sample to give an overall sense of the FUEL cohort.

As shown in the last column, many of the FUEL program students tend to be Hispanic or Latino (approximately 80 percent of the students overall). Many of the students are also low income, as judged by the number who qualify for free or reduced-price school lunch (83.5 and 6.8 percent, respectively). Many of the students were also labeled "Limited English Proficient" (15 percent) and nearly 9 percent were in special education some time during high school.

Table 1: The Characteristics of FUEL Participants

	Ongoing FUEL Participants		Withdrew from FUEL pre-2014	All FUEL Participants
	Joined Prior to 2014	Joined in 2014 (new Participants)		
Demographic Characteristics				
Female	0.536	0.590	0.541	0.550
White	0.084	0.033	0.000	0.061
Black	0.101	0.098	0.162	0.108
Asian	0.022	0.049	0.027	0.029
Hispanic	0.793	0.820	0.811	0.802
Native American	0.000	0.000	0.000	0.000
Income Measures				
Free Lunch	0.866	0.672	0.946	0.835
Reduced-Price Lunch	0.034	0.197	0.027	0.068
Educational Categories				
Limited English Proficient	0.190	0.066	0.108	0.151
In Special Education	0.089	0.082	0.081	0.086
Observations	179	61	37	278

Source: Chelsea High School administrative records from 2012-13 and 2013-14.

However, there are some differences between the students whose families joined FUEL earlier versus later and those who families withdrew from FUEL. Interestingly, the new participants in FUEL in 2014 appear to have slightly higher family incomes and were less likely to be categorized as "Limited English Proficient." A similarly-high proportion of them are

Hispanic but fewer of them are White/Caucasian. Overall, the students of parents in FUEL are more likely to be female with the proportion being nearly six out of ten students in the newer sample of participants.

Meanwhile, families who withdraw from FUEL before the student graduates from high school (i.e., the 37 families identified in earlier data) are far more likely to have qualified for "free lunch" than other FUEL families, thereby suggesting they more likely to come from the lowest income group than families who persist in FUEL. The racial-ethnic composition of the group that leaves FUEL is also different than the group that remains and more likely to be labeled "Limited English Proficient" at some time during high school.

As suggested by the summary statistics, a number of the students whose parents are a part of FUEL are from countries outside of the United States. Table 2 displays the breakdown by country of origin. Only 69 percent of FUEL students were born in the United States. Twenty students (8.3 percent) were instead born in El Salvador, followed by Somalia (5 percent of FUEL students). Other countries from which there are multiple FUEL participants include Iraq, Guatemala, and Honduras. As illustrated in earlier reports of our analysis of survey and interview data, many of the parents in FUEL did not grow up in the context of the United States and so are not familiar with the college enrollment process and factors that are important for helping students prepare for higher education. This highlights a key opportunity for FUEL to make a difference.

Table 2: FUEL Participants Country of Origin

	Frequency	Percentage
United States	166	69.17
El Salvador	20	8.33
Somalia	11	4.58
Iraq	7	2.92
Guatemala	6	2.50
Honduras	5	2.08
Colombia	3	1.25
Dominican Republic	3	1.25
Bhutan	2	0.83
Cape Verde	2	0.83
Mexico	2	0.83
Puerto Rico	2	0.83
Santo Domingo	2	0.83
Uruguay	2	0.83

Source: Chelsea High School administrative records from 2012-13 and 2013-14.

b. Comparing the Backgrounds of FUEL Participants to Other Students

To understand the effects of FUEL, it is important to compare the experiences and outcomes of FUEL students to other similar students. The ideal research design would be to randomly assign interested students and their families to either participate in FUEL or to face the standard "business as usual" conditions. Such a design would insure that there is a strong

comparison group that would have the same average characteristics and unobservable factors such as effort, motivation, and aspirations—the only difference would be who participated in FUEL or not. Obviously, there are also drawbacks to this research design, namely that the goal of FUEL is to help as many interested families as possible. Therefore, I use several other comparison groups as proxies for the outcomes students would have faced had their families not participated in FUEL.

The first comparison group is students whose families participated in FUEL but withdrew before the student graduated high school. This group may have similar levels of interest in supporting their child's education because they originally sought to participate in FUEL. However, the fact that they withdrew may signal their motivation is lower than FUEL families who remained in the program. Alternatively, there may have been some change in the family circumstance that precipitated their decision to leave FUEL, and if that reason also had a negative effect on their child's academic performance (e.g., loss of a job or income), then it will be hard to disentangle what is the true driver of differences in outcomes.[3] As discussed above, based on limited data on 37 families, a comparison of the student characteristics suggests that FUEL families that persist do differ from those who do not, and so the groups are not completely comparable.

Table 3: Comparing FUEL and non-FUEL students at Chelsea High School

	All Ongoing FUEL Participants	Students not in FUEL
Demographic Characteristics		
Female	0.550	0.468
White	0.071	0.078
Black	0.100	0.089
Asian	0.029	0.028
Hispanic	0.800	0.802
Native American	0.000	0.003
Income Measures		
Free Lunch	0.817	0.870
Reduced-Price Lunch	0.075	0.054
Educational Categories		
Limited English Proficient	0.158	0.357
In Special Education	0.088	0.135
Observations	240	1,456

Source: Chelsea High School administrative records from 2012-13 and 2013-14.
Notes: These data reflect the characteristics of student to 2013-14 school year. This table does not include the 37 students known to have withdrawn from FUEL prior to 2014.

[3] When comparing families who participate in FUEL over the longer term versus those who withdrawal from the program and stop participating before the student graduates from high school, it is clear there are differences in student characteristics. Families who withdraw from FUEL are far more likely to have qualified for "free lunch," suggesting they more likely to come from the lowest income group than families who persist in FUEL. They were also slightly more like to be Black in comparison to the group who persisted in FUEL.

The second, and main, comparison group is other students at Chelsea High School who were not a part of FUEL. The data agreement with the school district allows for this type of analysis to give a fuller picture of the entire school and how FUEL may have changed the educational trajectories of participants. However, because families do not enroll in FUEL randomly, the families and students in FUEL are likely to be different from other families and students. As shown in Table 3, a comparison of FUEL and non-FUEL student characteristics confirms this.

Comparing the backgrounds FUEL participants and non-participants, it is evident that groups different in multiple ways. First, families in FUEL are much more likely to have female children than male children; 55 percent of the students whose parents participate in FUEL are girls. The opposite is true among the rest of the school population, which has a higher proportion of male students. The racial composition of the FUEL group is similar to the rest of the school, though there was a slightly higher percentages of White students and slightly smaller percentage of Black students in the general student body. With regards to income, the families in FUEL seem to have slightly higher incomes in general. This is reflected by the fact that few of the FUEL families qualify for "free lunch" than families in the rest of the school. However, for both groups, almost all students have low enough incomes to qualify for free or reduced lunch.

There are big differences in other educational categories. Students in FUEL are far less likely to be labeled as "Limited English Proficient" (15.8 percent) in comparison to students not in FUEL (35.7 percent). They are also less likely to be in Special Education (8.8 versus 13.5 percent, respectively). These differences could have important implications for this research. Students in these categories are less likely to attend college, which may explain the differences in FUEL participation by student characteristics. Moreover, these students may progress academically at a slower pace and have lower levels of achievement. As such, simple comparisons of the academic outcomes of FUEL students to students outside of the program may partly reflect differences in background and education program in addition to capturing the effects of FUEL. Later in the analysis, I attempt to control for these differences using regression analysis.

While Table 3 gives a sense of the *observables* differences across groups, it is also likely that there are *unobservable* differences between the groups. Families who participate in FUEL may have higher levels of motivation and commitment to support their kids' preparation for college. Alternatively, they may be families who have better information networks that enabled them to know about the benefits of FUEL or they could adjust their schedules and use other supports to allow them to attend meetings and participate. If these unobservable differences also spur more positive educational outcomes (e.g., parents who are more committed to education have children with higher grades), then any differences in outcomes found between FUEL and non-FUEL families may be partly attributed to these other characteristics. As such, **in the forthcoming analysis, we must be careful to interpret the results not only being explained by the effects of participation in FUEL but also possibly being driven by these unobserved differences between FUEL students and comparison groups. Even after controlling for observable difference, these results are correlations rather than estimates of causal effects.**

III. DESCRIPTIVE ANALYSIS

a. The Educational Performance of FUEL Participants relative to Other Students

The data from the Chelsea School District provide several measures of academic performance and achievement levels. I begin by looking at MCAS performance, the state exam taken during the 10th grade. Because all families do not begin participating in FUEL before 10th grade, is not a definitive measure of the effects of FUEL participation; later analyses look at outcomes in the 11th and 12th grades and may do a better job capturing the "after" effects of participation in FUEL. However, because the majority of families start to participate in FUEL early in high school, the MCAS results are still useful as early, but imperfect, indicators of the effects of FUEL on academic performance.

From the school administrative records, we have score information on both the English Language Arts and Math exams. Two measures are reported: scaled scores and the student growth percentile. The scaled scores range from 200 to 280 with a score of 240 and above being judged as "Proficient." In contrast, the student growth percentile is meant to measure change in achievement over time for the student. It reflects a comparison of the change in the student's MCAS performance relative to other students in the state that had similar historical MCAS scores.[4]

In Table 4, the first column of results show the means for students whose families started to participate in FUEL before the most recent data extract of 2014, while the second column shows the results for the newest FUEL participants. Given the timing of the MCAS test and the desire to measure the effects of prolonged participation in FUEL, I focus on the results of the older group (the first column) and compare them to the final column, which shows the same outcomes for students whose families did not participate in FUEL. For each measure, the FUEL students outperformed students not in FUEL. Their 10th grade level of achievement was higher in English Language Arts (250.1 versus 243.7) and Math (248.5 versus 239.1). The average score of students in the general population of Chelsea High School would be deemed as barely "Proficient."

The differences between the student groups are not only in 10th grade performance but also the growth in their performance over time. The student growth percentiles suggest FUEL students made larger gains in performance in English Language Arts (76th versus 59th percentile) and Math (72nd versus 60th percentile.) Stated another way, the scores suggest that FUEL students had a stronger upward trajectory of academic performance than students whose parents did not participate in FUEL. For students whose parents began participating in 9th grade, some of this positive performance and gain could be contributed to FUEL. On the other hand, the differences might also reflect how families in FUEL different from other families even before receiving FUEL supports and information. Therefore, I now turn to information from the student transcript data.

[4] For more information on the student growth percentile measure, see: http://www.doe.mass.edu/mcas/growth/faq.html?section=overview

Table 4: Mean MCAS Performance (10th Grade)

	FUEL Participants			Chelsea Students not in FUEL
	Joined Prior to 2014	Joined in 2014 (new Participants)	Ongoing FUEL Participants	
MCAS Scaled Score in English Language Arts	250.12 (13.47) [172]	244.07 (13.59) [56]	248.63 (13.72) [228]	243.67 (14.80) [1,144]
MCAS Student Growth Percentile in English Language Arts	75.93 (23.59) [151]	58.91 (26.75) [53]	71.51 (25.50) [204]	59.28 (27.56) [950]
MCAS Scaled Score in Math	248.52 (18.14) [177]	238.89 (19.07) [56]	246.21 (18.78) [233]	239.11 (18.19) [1,164]
MCAS Student Growth Percentile in Math	71.81 (23.46) [150]	46.79 (29.13) [53]	65.28 (27.31) [203]	59.73 (28.97) [947]

Source: Chelsea High School administrative records from 2012-13 and 2013-14.
Notes: Means are reported with standard deviations in parentheses. Because the sample size for each summary statistic varies by data availability, the number of observations for each calculation are reflected in brackets. This table does not include the 37 students known to have withdrawn from FUEL prior to 2014.

Performance in high school courses provides a better measure of academic performance levels. Using transcript data from 2012-13 and 2013-14, I am able to better construct "before" and "after" comparisons by looking at 9th or 10th grade performance relative to 11th or 12th grade performance.[5] Unfortunately, because not all of the students in FUEL have progressed to high school graduation, I do not have grade information for most students for the 12th grade. Also, as shown in brackets in the next couple of tables, the number of student grades used to calculate the means for each cell varies. This is because some students do not take all of the courses all of the years. For instance, students are less likely to take a History course during the 12th grade than an English course.

Table 5 focuses on grades in English and History courses, with the former being displayed in the upper panel and the latter being in the bottom panel. By reading down a column, one can see how average grades change over time. For instance, among students whose parents joined FUEL before 2014, their average English grade (out of 100) during their freshmen year was 79.46 and in the 12th grade it was 77.02. Meanwhile, newer FUEL participants had higher average English grades in the 10th and 11th grades in comparison to freshmen year. With only two years of transcript data, it's important to note that I cannot track a specific student from freshmen to junior or senior year, so this is not a true measure of changes in grades for a particular student. Additionally, given the limited sample size for 12th grade, I have more confidence in the 11th grade results as a measure of the "after" effects of FUEL.

[5] Unfortunately, 90 FUEL participants do not have transcript data for that year, so they are not included in this analysis.

Even after acknowledging the shortcomings of the data, it is useful to see if there is a general trend upward or downward. Another thing that is especially clear is that students whose families are in FUEL, whether as long-time participants, new joiners, or families who withdrew, have higher average grades than students who parents were never a part of FUEL. Since the differences are evident even in the 9th grade, when presumably many families have not yet joined FUEL or experienced the full benefits of the program, then this could be some indication of FUEL families' commitment to education or a higher likelihood of their children continuing on to higher education even before any intervention.

Table 5: Mean Course Grades in English and History, 2012-13 and 2013-14

	Ongoing FUEL Participants		Withdrew from FUEL	Not in FUEL
	Joined Prior to 2014	Joined in 2014 (new Participants)		
Mean Grades in English Courses				
9th Grade	79.46 (12.6) [57]	69.83 (15.2) [18]	76.96 (12.2) [46]	71.21 (17.3) [2,218]
10th Grade	74.62 (18.7) [71]	80.71 (12.6) [14]	70.49 (16.1) [49]	67.63 (18.5) [1,769]
11th Grade	76.14 (14.0) [90]	79.38 (7.5) [8]	72.69 (20.1) [42]	67.18 (18.4) [1,312]
12th Grade	77.02 (14.7) [53]	---	75.22 (10.6) [27]	72.20 (14.8) [1,218]
Mean Grades in History Courses				
9th Grade	79.61 (14.2) [55]	71.72 (13.8) [18]	72.60 (13.6) [45]	69.02 (17.0) [2,212]
10th Grade	76.18 (16.9) [79]	77.71 (11.7) [14]	69.03 (14.4) [43]	67.14 (17.7) [1,834]
11th Grade	75.03 (12.2) [89]	82.75 (10.3) [8]	69.05 (18.3) [44]	68.49 (16.9) [1,296]
12th Grade	72.71 (19.1) [27]	---	62.80 (15.2) [5]	69.23 (15.4) [448]

Source: Chelsea High School student transcript records from 2012-13 and 2013-14.
Notes: Means are reported with standard deviations in parentheses. Because the sample size for each summary statistic varies by data availability, the number of observations for each calculation are reflected in brackets. This table does not include the 37 students known to have withdrawn from FUEL prior to 2014.

Table 6 shows similar results as Table 5 but instead focuses on Math and Science courses. In each of these subjects, we again see the pattern that FUEL students have higher averages grades than non-FUEL students; this is also the case in comparison to students whose families withdrew from FUEL. It is also interesting how course-taking trends vary across the student groups. While the bulk of the students in the FUEL sample are in 10th and 11th grade, it appears that a large proportion of FUEL students go on to take Math and Science in the 12th grade (judged by the sample size for those cells, which is reflected in brackets). In contrast, a far smaller proportion of non-FUEL students are taking those upper-level courses in comparison to the number of students in lower grades. This is partly due to high school dropout rates, which I believe are fairly high among non-FUEL students, but I suspect that the differences between FUEL and non-FUEL students is not only course performance but also course selection. Taking an additional math and science courses would indicate the student is doing a "college prep" high school curriculum.

Table 6: Mean Course Grades in Math and Science, 2012-13 and 2013-14

	Ongoing FUEL Participants		Withdrew from FUEL	Not in FUEL
	Joined Prior to 2014	Joined in 2014 (new Participants)		
Mean Grades in Math Courses				
9th Grade	78.05 (14.0) [54]	66.10 (14.9) [20]	69.78 (13.4) [43]	66.54 (18.2) [2,161]
10th Grade	75.59 (13.0) [88]	78.46 (13.8) [13]	72.01 (14.8) [42]	66.08 (16.9) [1,770]
11th Grade	77.06 (10.5) [89]	82.30 (11.8) [10]	68.22 (16.2) [41]	66.25 (17.1) [1,254]
12th Grade	80.48 (10.7) [39]	---	68.12 (14.9) [26]	69.70 (14.6) [1,041]
Mean Grades in Science Courses				
9th Grade	80.84 (12.2) [50]	75.00 (14.0) [13]	72.31 (16.2) [48]	65.89 (19.1) [2,169]
10th Grade	74.19 (18.3) [82]	78.55 (13.0) [15]	67.28 (17.8) [44]	65.66 (18.2) [1,894]
11th Grade	77.60 (13.9) [97]	80.10 (9.7) [10]	67.21 (20.2) [48]	68.09 (17.5) [1,369]
12th Grade	76.58 (11.3) [46]	---	71.16 (11.8) [19]	71.18 (16.2) [1,057]

Source: Chelsea High School student transcript records from 2012-13 and 2013-14.
Notes: Means are reported with standard deviations in parentheses. Because the sample size for each summary statistic varies by data availability, the number of observations for each calculation are reflected in brackets. This table does not include the 37 students known to have withdrawn from FUEL prior to 2014.

b. Comparing the Behavioral Outcomes of FUEL Participants relative to Other Students

While academic outcomes may be of the most interest, another possible effect of FUEL could be behavioral outcomes, such as truancy and suspensions. In the school administrative data, it appears that these two outcomes are relatively rare. However, there is good information on attendance, which could give some indication of behavior, commitment to education, and comfort in school. Perfect attendance would be represented by attending 180 days a school year.

Table 7: School Attendance for FUEL Participants in comparison to Other Students

	FUEL Participants			Chelsea Students not in FUEL
	Joined Prior to 2014	Joined in 2014 (new Participants)	All Participants	
9th Grade Attendance (days)	166.4 (34.6) [144]	167.3 (37.1) [19]	166.5 (34.8) [163]	151.8 (45.4) [1,301]
10th Grade Attendance (days)	166.7 (29.9) [152]	176.2 (4.0) [11]	167.3 (29.0) [163]	156.1 (38.0) [868]
11th Grade Attendance (days)	172.0 (13.1) [119]	176.3 (5.7) [8]	172.3 (12.8) [127]	152.0 (42.0) [533]
12th Grade Attendance (days)	166.6 (29.0) [88]			125.2 (59.3) [83]

Source: Chelsea High School administrative records from 2012-13 and 2013-14.
Notes: Means are reported with standard deviations in parentheses. Because the sample size for each summary statistic varies by data availability, the number of observations for each calculation are reflected in brackets. This table does not include the 37 students known to have withdrawn from FUEL prior to 2014.

Similar to earlier patterns found across groups, the FUEL students have higher attendance levels. The levels are particularly high during junior year. In comparison, Non-FUEL students miss about two to three weeks more of school (10 to 15 days). There are very limited attendance records for non-FUEL students during 12th grade, but the mean suggests students are absent a substantial number of days that year while FUEL students remained engaged and attend at much higher rates.

c. The Educational Trajectories and Aspirations of FUEL Participants relative to Other Students

When students graduate high school, they are surveyed about their future plans, and the Chelsea administrative data contains that information. Responses range from college to military to work, and the results are summarized in Table 8. The sample only includes students who began in FUEL prior to 2014 because newer participants had not yet graduated from high school by the end of the 2013-14 school year. For the cohorts that began in FUEL before 2014, there are marked differences in plans at graduation in comparison to non-FUEL students. FUEL students were much more likely to say they planned to go to college. Additionally, over half reported plans to attend a four-year college with another 39 percent saying they planned to go to a two-year college. Non-FUEL students had the opposite results, with over half signaling they intended to go to a community college. Fewer non-FUEL students planned to go to college at all, as more of them reported that they planned to work or go into the military.

Table 8: Plans at Graduation

	FUEL Participants who began before 2014	Chelsea Students not in FUEL
Four-Year College	54.77	28.20
Four-Year Private College	*34.53*	*12.82*
Four-Year Public College	*20.24*	*15.38*
Two-Year College	39.29	53.34
Two-Year Public College	*39.29*	*52.31*
Two-Year Private College		*1.03*
Trade School		3.08
Military	1.19	2.56
Work		8.21
Plans Unknown	4.76	3.59
Observations	84	195

Notes: If the student graduated, the survey asked what the student indicated as his/her plans following graduation.

Surveys about plans after high school graduation are not as strong an indicator of enrollment in higher education as actual college records of attendance, but they still provide some hope that the educational trajectories of FUEL students were much higher and steeper than their non-FUEL counterparts. These differences are substantial, and given the goals of FUEL, they could indicate a strong positive effect from the program. However, these descriptive comparisons are limited in their inferential power, and so the next section uses regression analysis to attempt to better estimate the effects of FUEL.

IV. REGRESSION ANALYSIS: THE EFFECT OF FUEL AFTER CONTROLLING FOR STUDENT CHARACTERISTICS

In an earlier research report, due to the small sample size on FUEL participants and limited outcome information, it was difficult to produce results with any confidence. Many of

the estimates were not statistically significant, and it was unclear if this was due to having an insufficient sample size to detect the effects of FUEL. Moreover, with such a small sample size, there are greater concerns about selection issues with a particular cohort. With the addition of the 2013-14 data, I am able to look at more outcomes and make a more plausible case about the "before" versus "after" effects of participating in FUEL. In addition, by adding a new cohort of FUEL participants, I have increased the sample size of the "treatment group."

The advantage of regression analysis is that is allows me to control for multiple variables at the same time so that I can focus on the variable of interest (i.e., being a student whose parent is participating in FUEL). Put another way, I am able to account for differences across the FUEL and non-FUEL students using the variables in the data set, namely, demographic information, proxies for income (free or reduced-price lunch), and specific education categories (Limited English Proficiency and Special Education). The regression models hold those other variables constant so that I am left with students who are equal in terms of those observable characteristics but differ by FUEL participation. While this is a great improvement over the descriptive results, which are plagued by multiple interpretations due to differences across the groups, it is again important to remember the potential role of unobservables. There is very likely variation in motivation and commitment to education across the groups, but I have no way of measuring that or accounting for it in the models. As such, the issue of selection is still a concern when interpreting these results. Additionally, in regression analysis, I can only include students who have complete information; if a student is missing an important variable such as race/ethnicity or free/reduced-price lunch status, then they are dropped from regression estimation.

Following the order of outcomes in the descriptive analysis, I first present results for MCAS scores. Table 9 shows separate OLS regressions for the four MCAS outcomes: scaled scores and the student growth percentile for English Language Arts and Math. The top row shows the estimated relationship between a student being a FUEL participant and their test score. The other rows show how the other variables also relate to test scores, and they are shown to give a sense of the full model (they are excluded from future tables so that I can focused on the FUEL variables).

As shown in the top row, FUEL participants score higher on the MCAS than non-FUEL students even after controlling for differences in student background. Their 10^{th} grade MCAS scores are 2.7 points higher on average for the ELA exam and 5 points higher in math. The student growth percentiles for each test are also much higher. The asterisks highlight the fact that these results are statistically significant; in other words, the data suggest we should have a great deal of confidence in these estimates signaling true differences between the groups. In comparison to the descriptive results in Table 4, these differences are a little smaller because they now account for other differences in background.

Table 9: Differences in MCAS Scaled Scores and Student Growth Percentiles by FUEL Status after controlling for student demographics, income, and educational categories

	ELA Scaled Score	ELA Student Growth Percentile	Math Scaled Score	Math Student Growth Percentile
	(1)	(2)	(3)	(4)
FUEL Participant	2.71***	11.84***	5.04***	6.42***
	(0.63)	(1.54)	(0.81)	(1.63)
Demographic Characteristics				
Female	2.56***	0.80	-0.44	-2.63**
	(0.44)	(1.10)	(0.57)	(1.16)
Black	-2.29**	2.32	-4.66***	-7.91***
	(1.02)	(2.64)	(1.33)	(2.76)
Asian	6.90***	7.90**	11.16***	8.27**
	(1.51)	(3.83)	(1.93)	(3.98)
Hispanic	-2.50***	-0.87	-3.29***	-3.15
	(0.80)	(1.98)	(1.03)	(2.09)
Native American	-5.05	-20.76*	-9.87*	9.24
	(3.99)	(12.26)	(5.27)	(12.95)
Income Measures				
Free Lunch	-3.04***	-0.14	-2.10*	2.99
	(0.83)	(2.07)	(1.08)	(2.17)
Reduced-Price Lunch	-3.52***	1.10	-3.33**	-0.44
	(1.24)	(3.12)	(1.62)	(3.27)
Educational Categories				
Limited English Proficiency	-17.94***	7.98***	-18.43***	6.38***
	(0.52)	(1.56)	(0.67)	(1.63)
Special Education	-13.73***	-8.74***	-17.70***	-5.80***
	(0.61)	(1.51)	(0.81)	(1.61)
Constant	253.67***	59.22***	251.45***	60.96***
	(1.02)	(2.52)	(1.33)	(2.65)
R^2	0.39	0.05	0.32	0.03
N	3,006	2,484	3,063	2,474

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: ELA stands for English Language Arts. Standard errors are shown in parentheses. Each regression contains the following control variables: dummy variables for being female (reference category male), Black, Asian, Hispanic, or Native American (reference category White), income measures (dummy variables for having free lunch or reduced-price lunch), and special education categories (dummy variables for Limited English Proficiency and Special Education). Each model also includes a constant.

Table 10 also examines differences in MCAS scores, but I break the FUEL students into separate groups according to when the parent started participating and if the family withdrew from FUEL. For each one of those rows, the coefficients reflect the difference in test score in comparison to being a non-FUEL student. Based on these results, it's clear that students who were in FUEL the longest had the highest MCAS scores with a ELA student growth percentile that was 17 percentage points higher than non-FUEL students and a math scaled score that was

7.9 point higher. Meanwhile, students who had not been in FUEL for more than a year (they entered in 2014) or they withdrew often scored less than non-FUEL students as reflected by the negative estimate. This is suggestive evidence that FUEL makes a real difference for students who participate during high school because the higher "dosage" of FUEL (i.e., spending more time in the program) is related to higher test scores. However, as written above, the MCAS results are not perfect indicators of FUEL's effects given the exam is taken in 10th grade, and FUEL is designed to help students all the way to high school graduation.

Table 10: Differences in MCAS Scaled Scores and Student Growth Percentiles by FUEL Status after controlling for student demographics, income, and educational categories

	ELA Scaled Score	ELA Student Growth Percentile	Math Scaled Score	Math Student Growth Percentile
	(1)	(2)	(3)	(4)
FUEL Participants Before 2014	4.58***	16.99***	7.92***	13.48***
	(0.70)	(1.73)	(0.91)	(1.82)
Withdrew from FUEL	2.48**	-23.12***	1.91	-27.45***
	(1.25)	(3.16)	(1.64)	(3.36)
New 2014 FUEL Participants	-3.19***	-2.98	-4.46***	-14.05***
	(1.19)	(2.82)	(1.58)	(2.96)
R^2	0.40	0.09	0.32	0.08
N	3,097	2,560	3,156	2,548

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: ELA stands for English Language Arts. Standard errors are shown in parentheses. Each regression contains the following control variables: dummy variables for being female (reference category male), Black, Asian, Hispanic, or Native American (reference category White), income measures (dummy variables for having free lunch or reduced-price lunch), and special education categories (dummy variables for Limited English Proficiency and Special Education). Each model also includes a constant.

Table 11 turns the focus to high school grades. To be able to display more results in one table, each numbered set of cells represents a separate regression. Each regression contains the same controls as the above models: gender, race/ethnicity, income, education categories, and a constant. Reading across a row, one can get a sense of how the average grades for FUEL participants change relative to non-FUEL students. The first column (models 1, 5, 9, and 13) give the best measure of student achievement "before" FUEL participation, although because some families began to receive services during that year, it might be better defined as the "early" period. The last and second-to-last columns give a sense of the "after," though as noted in the table, those regressions have few observations to estimate the coefficients.

Reading across the table, it appears that differences in grades increase over time for English, History, and Math, which is suggestive evidence of a positive impact by FUEL. This is especially true for English: in 9th grade, there is not a statistically significant difference in grades between FUEL and non-FUEL students, but by sophomore year, there is a clear difference, and it rise to nearly 9 percentage points in the 11th grade. The magnitude of the increase over time is especially large for History and Math. Average grades in science are also higher for FUEL

students, but there is more fluctuation in the magnitude of the difference over time, which may be partly due to the changing underlying sample.

Table 11: Differences in High School Grades by FUEL Status after controlling for student demographics, income, and educational categories

	9th Grade	10th Grade	11th Grade	12th Grade
	(1)	(2)	(3)	(4)
English Grades				
FUEL Participant	2.18	5.18**	8.59***	4.96*
	(1.94)	(2.05)	(1.96)	(2.56)
R^2	0.15	0.08	0.11	0.13
N	1,339	1,004	664	325
	(5)	(6)	(7)	(8)
History Grades				
FUEL Participant	5.31***	8.09***	6.82***	8.72**
	(1.94)	(1.89)	(1.89)	(3.75)
R^2	0.12	0.10	0.09	0.27
N	1,390	1,058	679	97
	(9)	(10)	(11)	(12)
Math Grades				
FUEL Participant	5.36**	6.53***	9.26***	10.19***
	(2.11)	(1.70)	(1.76)	(2.67)
R^2	0.08	0.08	0.11	0.10
N	1,238	960	662	296
	(13)	(14)	(15)	(16)
Science Grades				
FUEL Participant	9.15***	5.73***	10.12***	6.67**
	(2.19)	(1.86)	(1.87)	(3.05)
R^2	0.17	0.12	0.10	0.12
N	1,336	1,105	733	258

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: Standard errors are shown in parentheses. Each regression contains the following control variables: dummy variables for being female (reference category male), Black, Asian, Hispanic, or Native American (reference category White), income measures (dummy variables for having free lunch or reduced-price lunch), and special education categories (dummy variables for Limited English Proficiency and Special Education). Each model also includes a constant.

Table 12 provides separate estimates for each FUEL group in terms of English grades, and similar to Table 10, I find that the grade results are very much driven by the experiences of the longer-term FUEL participants. Those students had grades that were four to eight percentage points higher on average than those not in FUEL. The difference in grades is especially large during 11th grade. New participants in FUEL also had higher grades than non-participants, but it is hard to know whether to attribute that to FUEL participation. In fact, the especially high grades of these students during sophomore and junior years might signal why their parents decided to join FUEL at that last stage: their children showed promise in terms of going to college.

Table 12: Differences in High School English Grades by FUEL Status after controlling for student demographics, income, and educational categories

	9th Grade	10th Grade	11th Grade	12th Grade
	(1)	(2)	(3)	(4)
FUEL Participants Before 2014	4.82**	4.36**	8.33***	5.08**
	(2.19)	(2.21)	(2.05)	(2.51)
New Participants in 2014	-5.95	9.78**	11.49*	
	(3.83)	(4.80)	(6.47)	
Withdrew from FUEL	3.03	0.06	5.53*	2.30
	(2.42)	(2.63)	(2.91)	(3.38)
R^2	0.15	0.08	0.10	0.12
N	1,385	1,053	706	352

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: Standard errors are shown in parentheses. Each regression contains the following control variables: dummy variables for being female (reference category male), Black, Asian, Hispanic, or Native American (reference category White), income measures (dummy variables for having free lunch or reduced-price lunch), and special education categories (dummy variables for Limited English Proficiency and Special Education). Each model also includes a constant.

To summarize the early regression results, it's clear that FUEL students do better on exams and have higher high school grades in key subjects. There is even suggestive evidence that the grade performance gap increases over time, from 9th to 11th or 12th grade, which might be partly attributable to participating and benefitting from FUEL. Table 13 goes a step farther to investigate the relationship between participating in FUEL and plans at graduation after holding constant all other characteristics to see if the ultimate goal, i.e., college access, is accomplished. In column (1), we see FUEL students had a 21 percent higher chance of planning to go to a four-year college holding constant student background. In column (2), when looking at the effects for long-term FUEL participants, the estimated effect gets even larger. Columns (3) and (4) instead look at the likelihood of any four- or two-year college, and the estimated effects are a little smaller. This is presumably because the real difference for FUEL students is their propensity to attend four-year colleges over two-year colleges. These are strong results, but it's worth highlighting the fact that these regressions are based on incredibly small samples of only 279 students; missing data results in limiting which students were a part of these models.

Table 13: Differences in High School Graduation Plans by FUEL Status after controlling for student demographics, income, and educational categories

	Plans to Attend a Four-year College		Plans to Attend a Four-year or Two-year College	
	(1)	(2)	(3)	(4)
FUEL Participant (joined pre-2014)	0.21***		0.11**	
	(0.06)		(0.04)	
Remained in FUEL (joined pre-2014)		0.25***		0.13***
		(0.06)		(0.05)
Withdrew from FUEL		0.08		0.05
		(0.10)		(0.08)
R^2	0.14	0.15	0.06	0.06
N	279	279	279	279

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: Standard errors are shown in parentheses. Each regression contains the following control variables: dummy variables for being female (reference category male), Black, Asian, Hispanic, or Native American (reference category White), income measures (dummy variables for having free lunch or reduced-price lunch), and special education categories (dummy variables for Limited English Proficiency and Special Education). Each model also includes a constant. No data are available for families that joined FUEL in 2014 because they have not reached high school graduation.

Table 14: Differences in High School Attendance after controlling for student demographics, income, and educational categories

	9th Grade	10th Grade	11th Grade	12th Grade
	(1)	(2)	(3)	(4)
FUEL Participants Before 2014	10.64***	9.53***	20.13***	43.64***
	(3.76)	(3.23)	(3.90)	(7.59)
New Participants in 2014	7.16	17.12	22.73*	
	(9.93)	(11.11)	(13.68)	
Withdrew from FUEL	13.56*	-1.77	8.13	-52.12
	(7.25)	(6.18)	(6.80)	(35.52)
R^2	0.10	0.04	0.07	0.22
N	1,464	1,031	660	171

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: Standard errors are shown in parentheses. Each regression contains the following control variables: dummy variables for being female (reference category male), Black, Asian, Hispanic, or Native American (reference category White), income measures (dummy variables for having free lunch or reduced-price lunch), and special education categories (dummy variables for Limited English Proficiency and Special Education). Each model also includes a constant.

Finally, Table 14 presents regression results regarding student attendance. Similar to the descriptive results, large differences are evident between long-time FUEL participants and non-FUEL students. Even during 9th grade, there is over a 10-day difference in the number days of school attended. This difference grows substantially over time to 12th grade, but the sample size declines as well. Interestingly, students who withdrew from FUEL also initially had higher attendance levels, but after freshman year, their attendance patterns were not statistically different from students who never were a part of FUEL. This could signal that leaving FUEL meant they did not get benefits or that something else changed in the family that affected school outcomes.

V. CONCLUSION

Both the descriptive results and regression analyses suggest that FUEL students do better on exams and have higher high school grades in key subjects. There is even suggestive evidence that that grade performance gap increases over time, from 9th to 11th or 12th grade, which might be partly attributable to participating in and benefitting from FUEL. FUEL students also seem to be more likely to take math and science classes as high school juniors and seniors, which could indicate a higher likelihood of preparing academically for college. Attendance levels are also much higher for FUEL students. Finally, student plans at graduation, as measured by a self-reported survey, suggest that FUEL students are much more likely to enroll at a four-year college than non-FUEL students. The difference is resounding and is suggestive of the positive benefits of FUEL. However, these results are not causal and may partly be driven by the fact that FUEL students are different from non-FUEL students in terms of observable characteristics and most likely also in terms of unobservable characteristics. Therefore, while the patterns evident in the data are quite complimentary of FUEL, the limitations of the research design and data do not allow for a more definitive conclusions about the magnitude of the causal effect of FUEL.

In conclusion, not only are families saving, but there also appears to be an effect on students' academic trajectories. These documented positive correlations should not be discounted—FUEL seems to play some role in improving student outcomes; it's just that I cannot quantify the exact size of the FUEL effect given other factors may also be contributing to the overall positive outcomes.

Hopefully, this analysis will help to serve Inversant. While the research has implications for efforts more broadly to engage parents and improve college access, this has essentially been a program evaluation, and there have been many lessons for the organization as it considers ways to better support their families. In many respects, the results suggest the model already works pretty well. However, from this analysis, it appears that starting earlier has stronger positive effects, as shown by the results for FUEL cohort that started before 2014 in comparison to those who started later. With more information about FUEL participation, one might be able to parse out the effects of different components of the FUEL model (by comparing families that received X services versus Y services) and investigate the role of dosage (i.e., how the intensity and length of time of the supports received influences outcomes).