

Impact of Learning Interventions: An Analytics Case Study with the Top School District in Indiana

Michael Jonelis, Alejandro Brillembourg Cuenca, Vivek Rao, Rupal Bilaiya, Sriya Musunuru, Dr. Yang Wang
Purdue University, Krannert School of Management
mjonelis@purdue.edu; abrillem@purdue.edu; rao161@purdue.edu; rbilaiya@purdue.edu; musunuru@purdue.edu; yangwang@purdue.edu

ABSTRACT

The COVID-19 pandemic disrupted education worldwide. Students missed out on in-person instruction and their performance saw a sharp decline. Our client — a school district in Indiana with more than 15,000 students — looked for creative ways to combat learning loss. In order to increase academic gains in this new environment with pre-existing systemic inequities, our client implemented two sets of treatments: summer school and three concurrent tutoring interventions. 3,500 students attended summer school and 1,400 students received some kind of tutoring. Tutoring was offered through school teachers (most used), contract teachers, and an external vendor (least used). Through this study, our client would like to measure the effect of each of these treatments on students' academic performance.

INTRODUCTION

The 87% increase of government funding in Education during the past five years shows how seriously the U.S. government and its citizens take this service. School districts should “collaborate with additional educational resources to tailor instruction for the individual or small groups, in particular those with specific learning needs” (Indiana Department of Education, 2021). There is no one-size-fits-all approach to education and our client focused their effort on a summer program and three tutoring delivery methods.

After data processing:

 **5,200**
Sampled Students

 **1,600**
Summer Students

 **700**
Tutored Students

RESEARCH OBJECTIVES

1. Can we perform clustering to group similar students together?
2. Did summer school have a noticeable impact on students' academic performance?
3. Did tutoring have a noticeable impact on students' academic performance?
4. Which of the four interventions was most effective; which of the three tutoring interventions was most effective?
5. Would one intervention be more effective than another when applied to students in a given cluster? Can we find an optimal treatment assignment for students to maximize academic gains?

LITERATURE REVIEW

	Student Grade Levels	Tutoring		Designs		Outcomes	
		In-Person	Online	Random Experiment	Multiple Treatments	Psychological Well-being	Academic Performance
Carlana & La Ferrara	6–8	✓	□	✓	□	✓	✓
Nickow et al	K–12	✓	□	✓	□	□	✓
Our Study	1–8	✓	✓	□	✓	□	✓

Table 1. Literature Review

METHODOLOGY

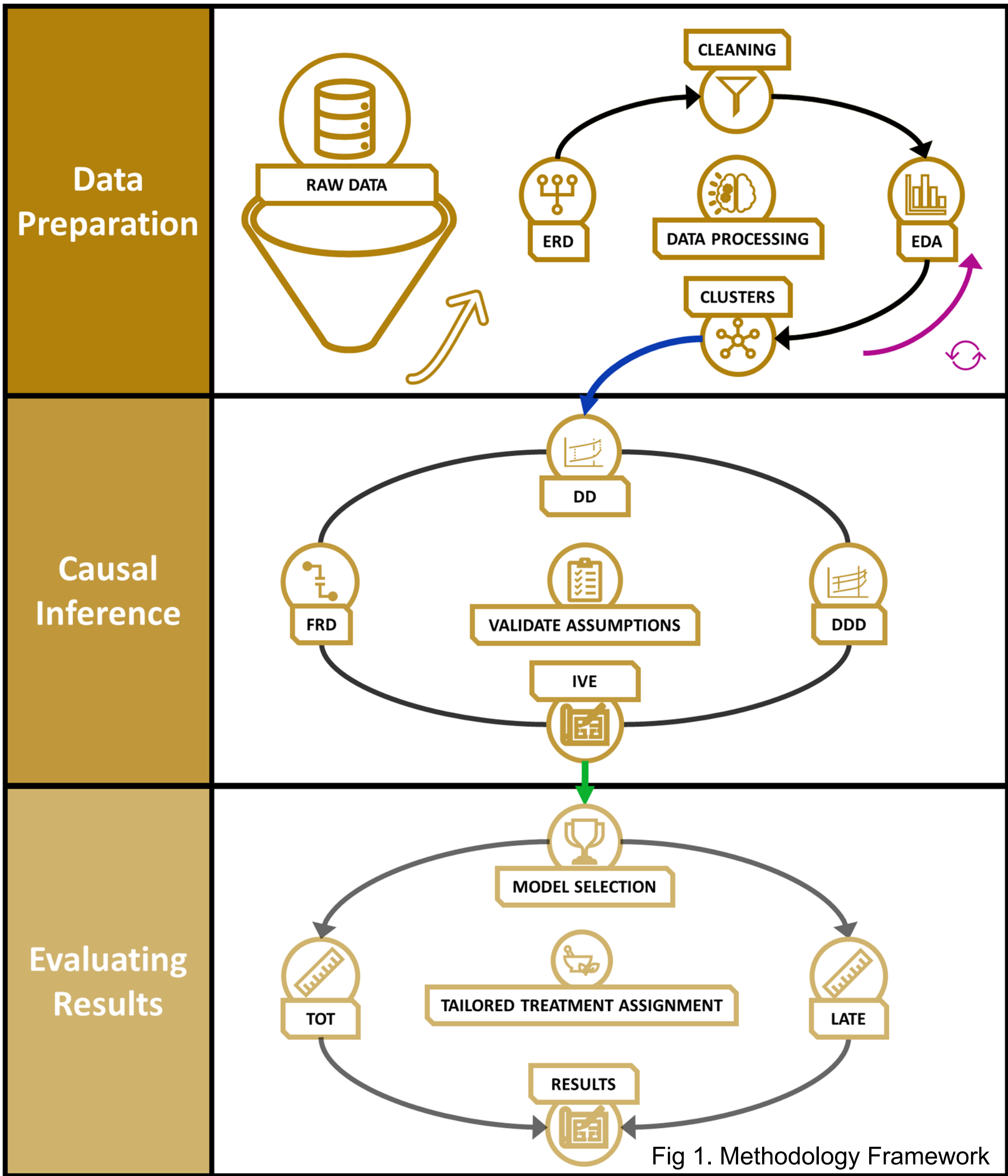


Fig 1. Methodology Framework

CLUSTERING

UMAP dimension reduction of dataset and BIRCH clustering. This reduced each student to a point in space with similar students positioned closer. We observed five clusters.

1. Hispanic, low-income, weak reading scores, at/above math benchmark
2. Black, low-income, history of homelessness, foster care, weak reading, math scores
3. Black and white, high-income, male, high reading and math scores
4. Black and white, high-income, female, high reading and math scores
5. Hispanic, low-income, immigrants, ESL, weak reading, mixed math

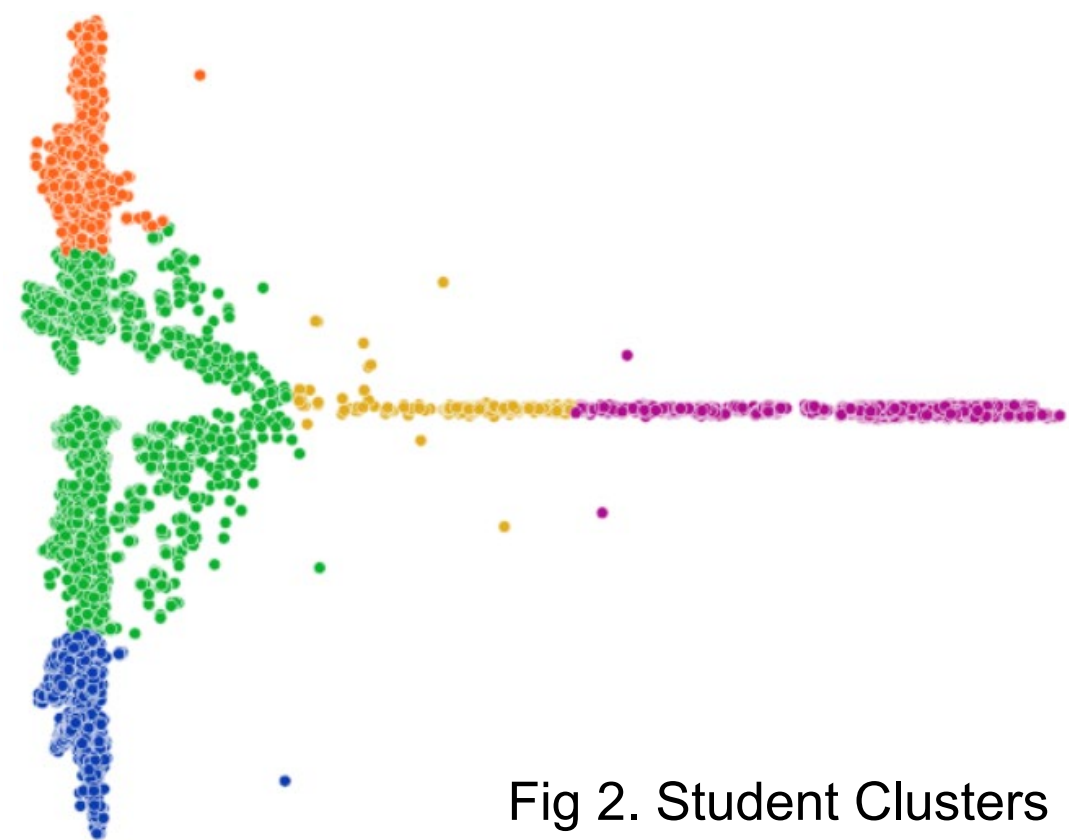


Fig 2. Student Clusters

STATISTICAL RESULTS

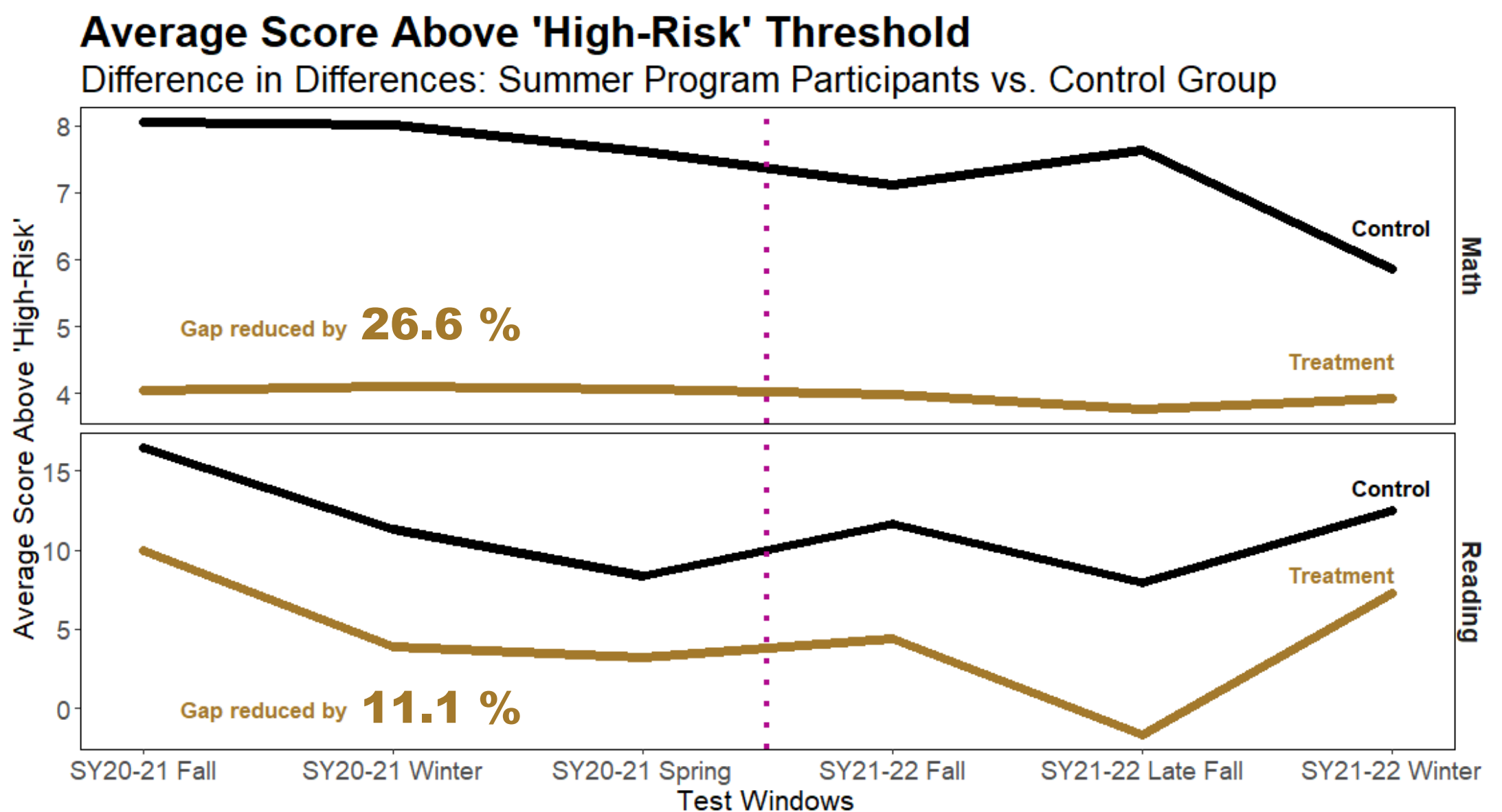


Fig 3. Difference-in-Difference Results - Summer

Characteristic	Significance	Growth
FT Tutoring	***	51.63
Sp Ed	***	-11.11
Summer	**	2.48
ESL	**	-3.08
LC: Free	-	0
LC: Reduced	-	0.41
LC: Normal	***	2.88

Fig 4. 2nd Stage IVE Full-Time Growth

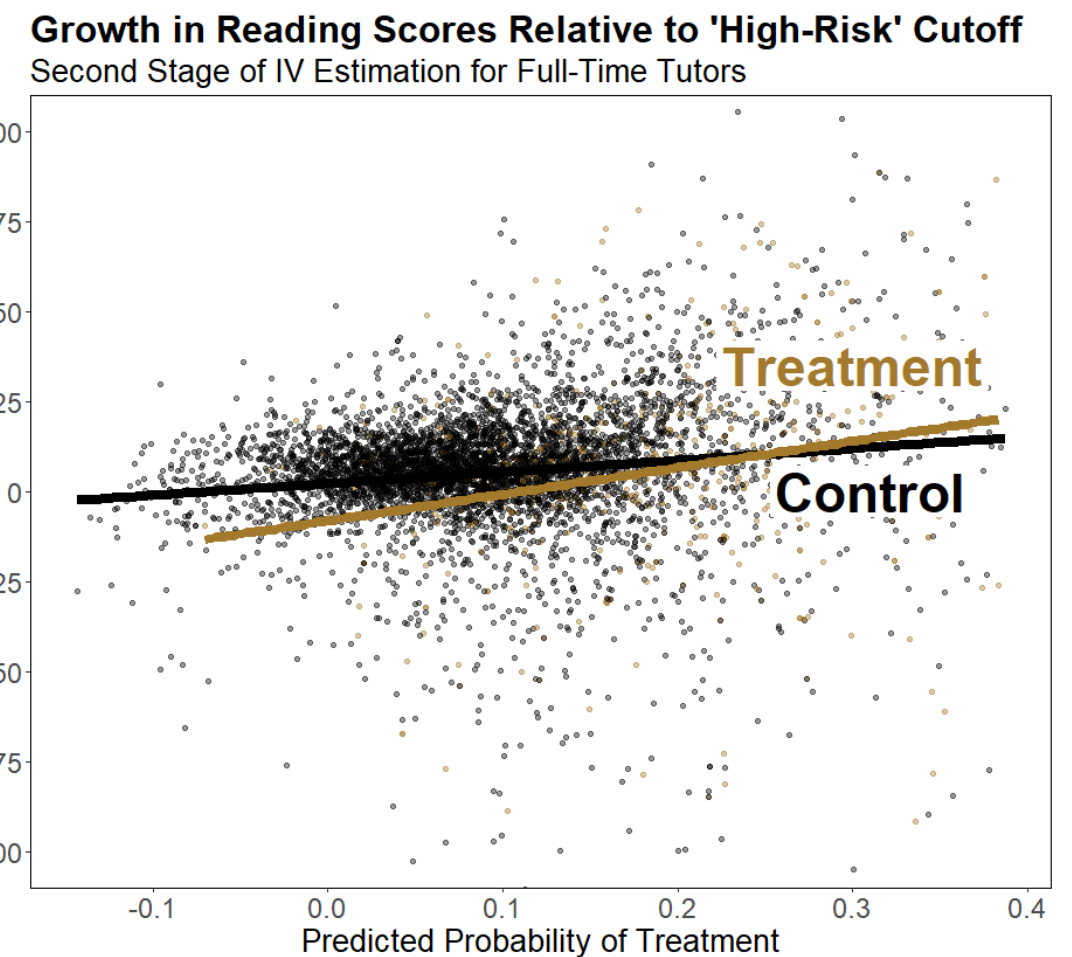


Fig 5. 2nd Stage IV Estimation FT

Characteristic	Significance	Growth
Summer + FT	***	153.41
Sp Ed	***	-13.11
ESL	-	-1.65
LC: Free	-	0
LC: Reduced	-	-0.19
LC: Normal	*	1.99

Fig 6. 2nd Stage IVE Summer+FT Growth

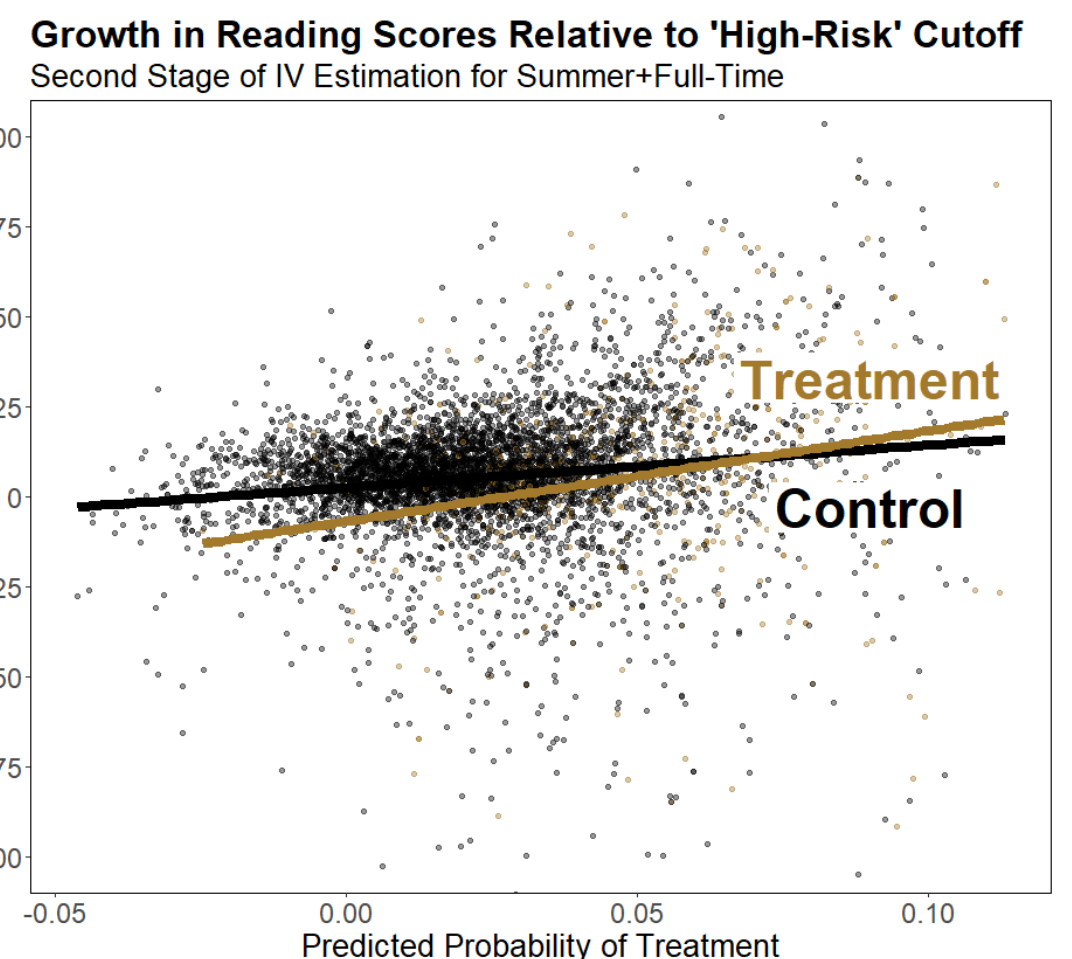


Fig 7. 2nd Stage IV Estimation S+FT

Students who received an intervention—either through Summer School or tutoring—grew at a faster rate relative to their peers for both Math and Reading. Those who received both interventions benefitted substantially.

EXPECTED IMPACT

Understanding how different students react to each intervention can generate higher academic gains. A one-size-fits-all approach is rarely appropriate in education. Below we can see that each of the five identified clusters experience different gains from tutoring by full-time teachers.

After performing similar analyses for the other treatments, the client can offer each student a tailored approach based on their unique characteristics.

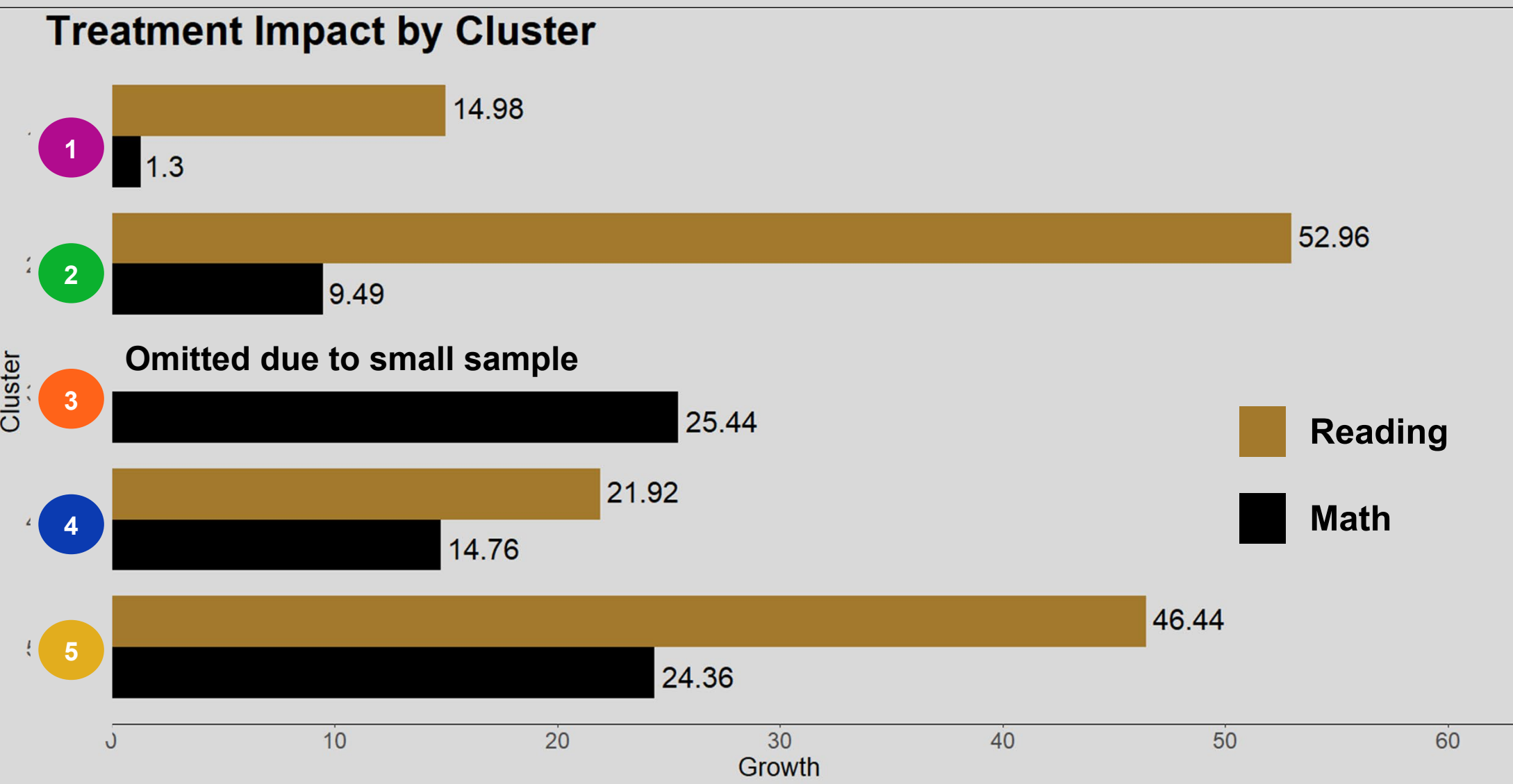


Fig 8. Impact of Full-Time Tutoring on Math and Reading Growth by Cluster

CONCLUSIONS

The findings of our study can be summarized as below:

1. We identified five student clusters based on academic and demographic information.
2. Summer school had a significant impact on struggling students.
3. Each tutoring program had a positive impact on student growth, but the magnitude of these effects is difficult to measure due to small treatment groups.
4. Summer school seemed to be the most impactful, followed by tutoring with full-time teachers; the magnitude of the other interventions is unclear.
5. We observe that student clusters react differently to treatments, offering our client the ability to make more personalized recommendations on how to aid students

While we were able to see positive impacts for the treatments, it is difficult to quantify the exact impact with less than 2% of the observed sample in some treatment groups. Larger treatment groups and a more structured assignment would allow for more accurate estimates of treatment effect.

ACKNOWLEDGEMENTS

We would like to thank the Krannert School of Management, Professors Yang Wang and Matthew Lanham, and our industry partner for providing a platform, offering guidance and collaboration, and supporting us throughout this project.



Landing page



Evaluation