# Analyzing the Impact of 21st CCLC Programs on Academic Achievement and Social-Emotional Wellness

by

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## *Abstract*

**This report examines the influence of participation in 21st Century Community Learning Centers (21st CCLC) programs on academic achievement and social-emotional wellness among students. Utilizing data from multiple schools across the academic years 2022-2023 and 2023-2024, the study employs statistical analyses, including paired t-tests, to assess changes in academic assessment scores, socioemotional measures, attendance rates, and incident reports. The findings demonstrate significant enhancements in STAR360 Math and Literacy scores, initial improvements in students' sense of belonging, and notable decreases in absenteeism and incidents. Furthermore, analyses across demographic groups highlight varied program impacts, emphasizing differential effects based on factors such as race, socioeconomic status, and English language learner status. The study concludes with implications for educational policy and recommendations for optimizing program effectiveness.**

# I. INTRODUCTION

The 21st Century Community Learning Centers (21st CCLC) program is a federal initiative aimed at creating community learning centers that provide academic enrichment opportunities outside traditional school hours. These programs are designed to support students, particularly those from high-poverty and low-performing schools, in meeting state and local standards in core academic subjects such as reading and math. Established by the U.S. Department of Education, the program seeks to provide a safe environment for students to receive academic support, engage in enriching activities, and develop essential social-emotional skills.

This project evaluates the effectiveness of 21st CCLC programs in enhancing both academic performance and socioemotional development among a diverse student body. Specifically, it investigates the impact of program participation on standardized academic assessment scores (e.g., STAR360 Math and Literacy, IAR Math and ELA), socioemotional indicators (e.g., sense of belonging), attendance records, and incident reports. By employing rigorous statistical methods and analyzing data from multiple schools, this study aims to offer empirically grounded insights into the efficacy of these initiatives.

This paper provides a comprehensive exploration of the 21st Century Community Learning Centers (21st CCLC) program and its impact on student outcomes. Section II offers an overview of the 21st CCLC program, detailing its objectives, implementation strategies, and intended benefits for participating students. Section III reviews relevant literature on after-school programs, focusing on their effectiveness in enhancing academic performance, socio-emotional development, and overall student well-being. Section IV outlines the dataset used in this study, encompassing academic performance metrics, socio-emotional wellness indicators, attendance records, and incident rates. Detailed descriptions of data sources and collection methods lay the groundwork for subsequent analyses, including steps taken to handle missing data, normalize variables, and select pertinent features for predictive modeling.

Section V discusses the modeling approach employed, while Section VI details the methodologies used in the study. Section VII presents the results and discussions, including findings from statistical analyses and their implications for the 21st CCLC program. Section VIII delves into ethical considerations, emphasizing privacy protection, informed consent, and maintaining research integrity throughout the study. Section IX synthesizes key findings and

conclusions drawn from the data analysis, highlighting the program's impact on various student outcomes. Finally, Section X offers recommendations for optimizing the effectiveness of the 21st CCLC program based on the study's findings and insights gained.

## II. OVERVIEW OF THE 21st CCLC PROGRAM

The 21st CCLC, funded by the U.S. Department of Education, is dedicated to providing academic enrichment opportunities outside of regular school hours, specifically targeting children from high-poverty and low-performing schools. The program aims to achieve the following primary goals:

A. *Providing Academic Support:* Offering remedial education and academic enrichment activities to bolster academic performance.
B. *Enhancing Social-Emotional:* Development: Providing supplementary activities such as counseling, art, music, and recreational programs to complement students' regular academic curriculum.
C. *Promoting Family Engagement:* Extending educational services to families of participating children to enhance their involvement and support in their educational journey.

This project encompasses data from ten participating schools in the 21st CCLC program, all from Valley View School District.

1) Bernard J. Ward Elementary School (BJW)
2) Brooks Middle School (BMS)
3) Hubert H. Humphrey Middle School (HHH)
4) Independence Elementary School (IND)
5) Irene H. King Elementary School (IHK)
6) John R. Tibbott Elementary School (JRT)
7) Kenneth L. Hermansen Elementary School (KLH)
8) Oak View Elementary School (OV)
9) Vito Martinez Middle School (AVM)
10) Woodview Elementary School (WV)

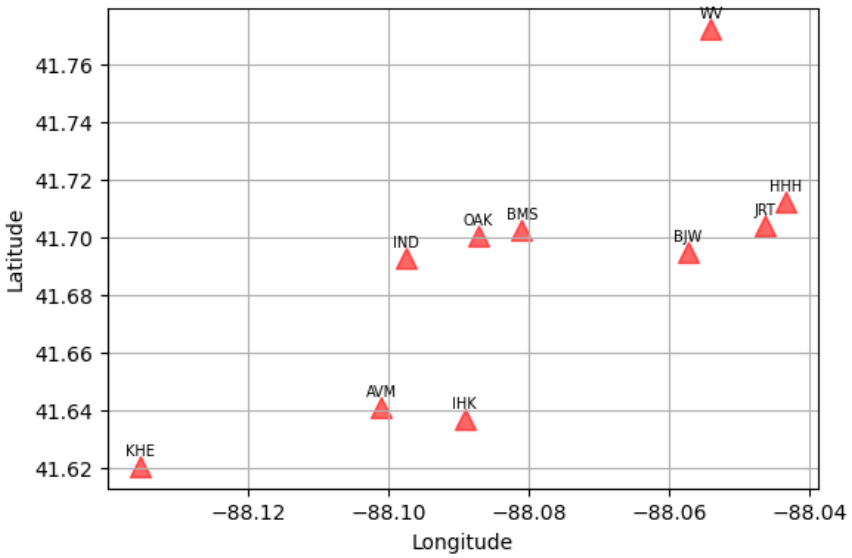


Fig. 1. Geographic Distribution of Schools in the 21st CCLC Program

Activities offered at these schools include STEM lessons, literacy education, academic enrichment, arts and music activities, promotion of healthy lifestyles, drug and violence prevention, career readiness programs, cultural programs, and specialized support for students with disabilities and English language learners (ELLs).

Despite recognizing the potential benefits of 21st CCLC programs, comprehensive research on their effectiveness across diverse demographic groups remains limited. This study aims to bridge this gap by evaluating the specific benefits of these programs and identifying optimal levels of participation. By analyzing the impact of participation in these programs on students' academic achievement and social-emotional wellness, the findings will provide valuable insights to educators and policymakers, aiming to optimize and tailor these programs to better support all students.

## III. RELATED WORK

Research has demonstrated the positive impact of after-school programs on student outcomes using various data-driven methods. Below are key studies that inform this research.

Little, Wimer, and Weiss [1] analyzed the effectiveness of after-school programs using a combination of quantitative data from standardized test scores and qualitative data from student

and teacher surveys. They found significant improvements in academic performance and social development among participants.

Ward et al. [2] employed a mixed-methods approach, integrating quantitative data from school attendance records and qualitative interviews with students and parents. Their study highlighted the role of structured after-school activities in improving student behavior and school attendance.

Durlak and Weissberg [3] conducted a meta-analysis of 75 studies on after-school programs, utilizing statistical techniques to measure effect sizes and determine the programs' impact on emotional regulation and social skills. Their findings indicated that high-quality after-school programs lead to better emotional regulation and social skills.

Vandell, Reisner, and Pierce [4] performed a longitudinal study involving regression analysis on academic performance data and behavioral assessments. They observed that consistent participation in after-school programs is associated with improved academic performance and reduced behavioral problems.

Granger [5] emphasized the importance of program quality in achieving positive outcomes, using hierarchical linear modeling to analyze data from multiple programs. His findings suggest that higher-quality programs yield better academic and social outcomes.

Kremer et al. [6] used a systematic review and meta-analysis to examine the effects of after-school programs on attendance and externalizing behaviors among at-risk youth. They employed random-effects models to synthesize findings across studies, concluding that after-school programs can reduce achievement gaps between low-income and higher-income students.

Shernoff [7] employed structural equation modeling to examine how engagement in after-school activities correlates with social competence. His analysis demonstrated that active participation in these programs significantly fosters positive youth development, emphasizing the beneficial impact of such engagements on students' social skills and overall growth.

Mahoney, Lord, and Carryl [8] conducted an ecological analysis using multivariate statistical techniques to study the impact of after-school program participation on academic performance and motivational attributes among disadvantaged children. Their study demonstrated that these programs provide a safe environment that can lead to better academic and social outcomes.

Gottfredson et al. [9] employed a randomized controlled trial design to assess the effects of after-school programs on middle school students. They used ANOVA and regression analysis to evaluate program impact, finding that structured environments and adult support are crucial for success.

Lauer et al. [10] performed a meta-analysis of out-of-school time programs, using weighted mean effect sizes to measure the impact on reading and math achievement. Their analysis confirmed the positive effects of these programs on academic outcomes for at-risk students.

These studies collectively highlight the significant positive impacts of after-school programs on both academic and social-emotional outcomes, employing a range of data-driven methods to derive their conclusions. This project aims to build on this existing research by leveraging advanced data analysis techniques, including machine learning models and statistical methods. By applying these sophisticated approaches to analyze data from the 21st CCLC program across various demographic groups, the study seeks to deepen our understanding of how program participation influences student performance and well-being. These techniques allow for the exploration of intricate relationships within large datasets, enabling the identification of key factors that contribute to educational success and socio-emotional development.

## IV. DATA OVERVIEW

The data utilized in this report originates from multiple sources, primarily from the Valley View School District and 21st CCLC program records. These sources provide comprehensive insights into student performance and development. Below is a detailed explanation of each data source:

### *A. Data Source*

#### *1) Valley View School District*

*a) STAR360 Assessments*: The STAR360 assessments are adaptive tests that evaluate student proficiency in math and reading. Conducted by school districts, these assessments provide percentile scores ranging from 0 to 100. They are administered at the beginning of Fall and the end of each Spring

term for the academic years 2022-23 and 2023-24. These assessments offer personalized insights into student growth over time.

b) *IAR Assessments*: The Illinois Assessment of Readiness (IAR) is a standardized test measuring students' mastery of Illinois Learning Standards in English Language Arts (ELA) and Mathematics. Administered by the Illinois State Board of Education, these tests categorize performance into five levels, from not meeting to exceeding expectations. The report compares scores from Spring 2022, Spring 2023, and Spring 2024.

c) *Panorama Student Survey Assessments*: Panorama Education administers surveys to assess various dimensions of student and school community experiences, including social-emotional learning, school climate, and teacher feedback, aiding schools and districts in data-driven decision-making for enhancing educational outcomes and student well-being. These surveys include assessments on emotional regulation, evaluating students' capacity to manage stress and recover from negative moods, conducted biannually since Fall 2022 with ratings from 1 to 5. Additionally, surveys measure social awareness, focusing on skills like empathy and effective communication, alongside assessing students' sense of belonging across Fall 2022 to Spring 2024, capturing perceptions of inclusion and community connection.

d) *Demographics*: Demographic data such as gender, race/ethnicity, school, grade, free/reduced lunch (FRL) eligibility, English Language Learner (ELL) status, and Individualized Education Program (IEP) status were obtained from the school district.

2) *21st CCLC Program Records*: These records encompass activities supporting students' academic, social-emotional, and personal development outside regular school hours. Activities include STEM lessons like Wonder Works and Simple Machines, literacy education, academic enrichment, arts and music activities, physical fitness programs, social-emotional learning, career readiness, cultural celebrations, and support for students with disabilities.

## B. *Data Preprocessing*

1) *Dataset Integration and Cleaning:* The data were received in both Excel (.xlsx) and CSV (.csv) formats. All data from these sources were merged based on Student ID as a unique identifier using Python and the pandas library. Duplicate entries were removed, and student IDs and names were verified with schools for accuracy. An outer merge was performed across four years, from Spring 2020 to Spring 2024. The initial dataset included 2,095 students participating in the 21st CCLC program. Due to varying participation levels, the analysis focused primarily on the academic years 2022-2023 and 2023-2024, with a sample size of 320 students and 67 distinct variables.

2) *Handling Missing Values:* Addressing missing data in our longitudinal dataset spanning four years posed significant challenges. The variability in student participation across years and varying survey requirements by grade contributed to incomplete rows. Initial attempts using mean imputation proved ineffective due to skewed data distributions. Dropping incomplete rows was deemed unsuitable as it led to a drastic reduction in our dataset from 2095 to 320 entries, potentially losing valuable information from other columns. Fortunately, demographic columns including Gender, Race and Ethnicity, ELL, IEP, and FRL exhibited complete data, ensuring robustness for demographic analyses. Similarly, comprehensive data coverage was observed in metrics such as total hours across academic years and incidents and absentee rates, facilitating detailed trend analysis. However, assessments and survey scores showed varying degrees of missing data. Notably, assessments like IAR-Math Spring 2022 (143.5) and Star360 Math Fall 2023 (51.1) had higher percentages of missing values, underscoring the need for advanced data completeness strategies. Therefore, we implemented iterative imputation using the IterativeImputer from the scikit-learn library, employing BayesianRidge as the estimator. This method iteratively models each feature based on others, providing a robust solution for imputing missing numeric data. Following these procedures and validating the dataset, we confirmed no remaining missing values, ensuring data integrity for thorough analysis and informed decision-making in our report.

3) *Handling Outliers:* Outliers were identified within the dataset using methods such as visual inspection and statistical techniques like the Interquartile Range (IQR) method. It was determined that these outliers represented genuine data points rather than data entry errors or anomalies. Therefore, a decision was made to retain these outliers to ensure the integrity and accuracy of the dataset, avoiding potential biases in subsequent analyses.

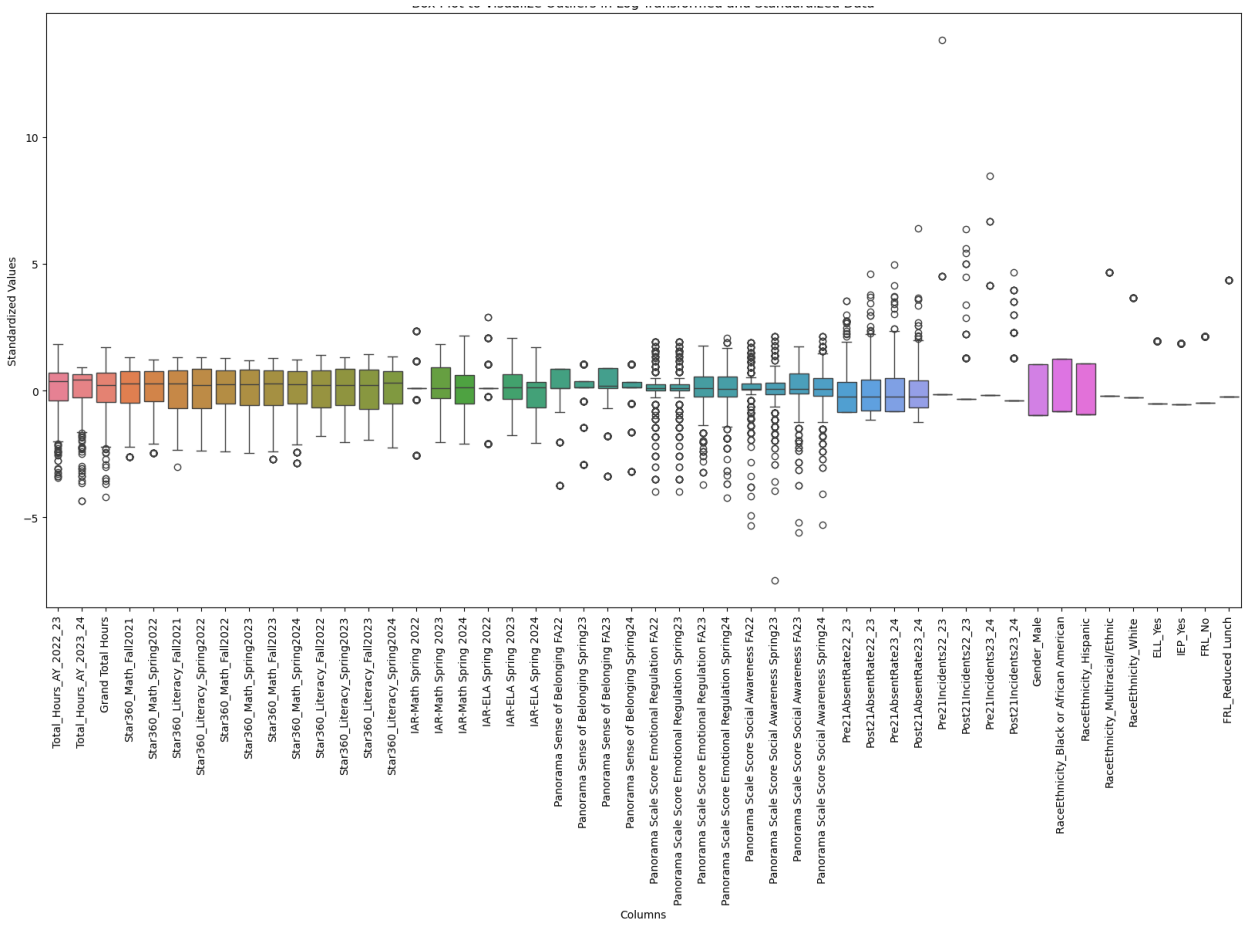


Fig. 2. Box Plot to visualize outliers

## C. *Data Transformation*

1) *One-Hot Encoding:* To prepare categorical variables for modeling, we utilized one-hot encoding from the sklearn library. This transformation converted categorical features such

as race and ethnicity, free and reduced lunch (FRL) status, English language learner (ELL) status, and gender into numerical representations suitable for analysis.

2) *Normalization/Standardization of Data:* Given the disparate scales of our data, we employed the MinMaxScaler from sklearn to standardize it, ensuring all variables were on a comparable scale. This normalization facilitates more effective modeling and interpretation across different features.

*D. Feature Engineering*

We conducted feature engineering to derive new insights from existing data:

1) *Derived Features*: New metrics were generated, including changes in assessment scores, attendance rates, and other relevant indicators. These engineered features aimed to capture dynamic aspects of student performance and engagement over time.

*E. Feature Selection*

Our feature selection process was rigorous and guided by the study's objectives:

1) *Comprehensive Criteria*: Features were selected based on their significance in evaluating the impact of 21st CCLC participation on student outcomes. This encompassed demographic indicators, academic performance metrics (such as assessment scores), socioemotional assessments, attendance records, incident reports, and cumulative program participation hours.

2) *Informed Decisions*: Selections were informed by insights from literature reviews, consultations with domain experts, and correlation analyses. The goal was to uncover meaningful associations and provide a holistic understanding of how program participation influences academic and socioemotional outcomes.

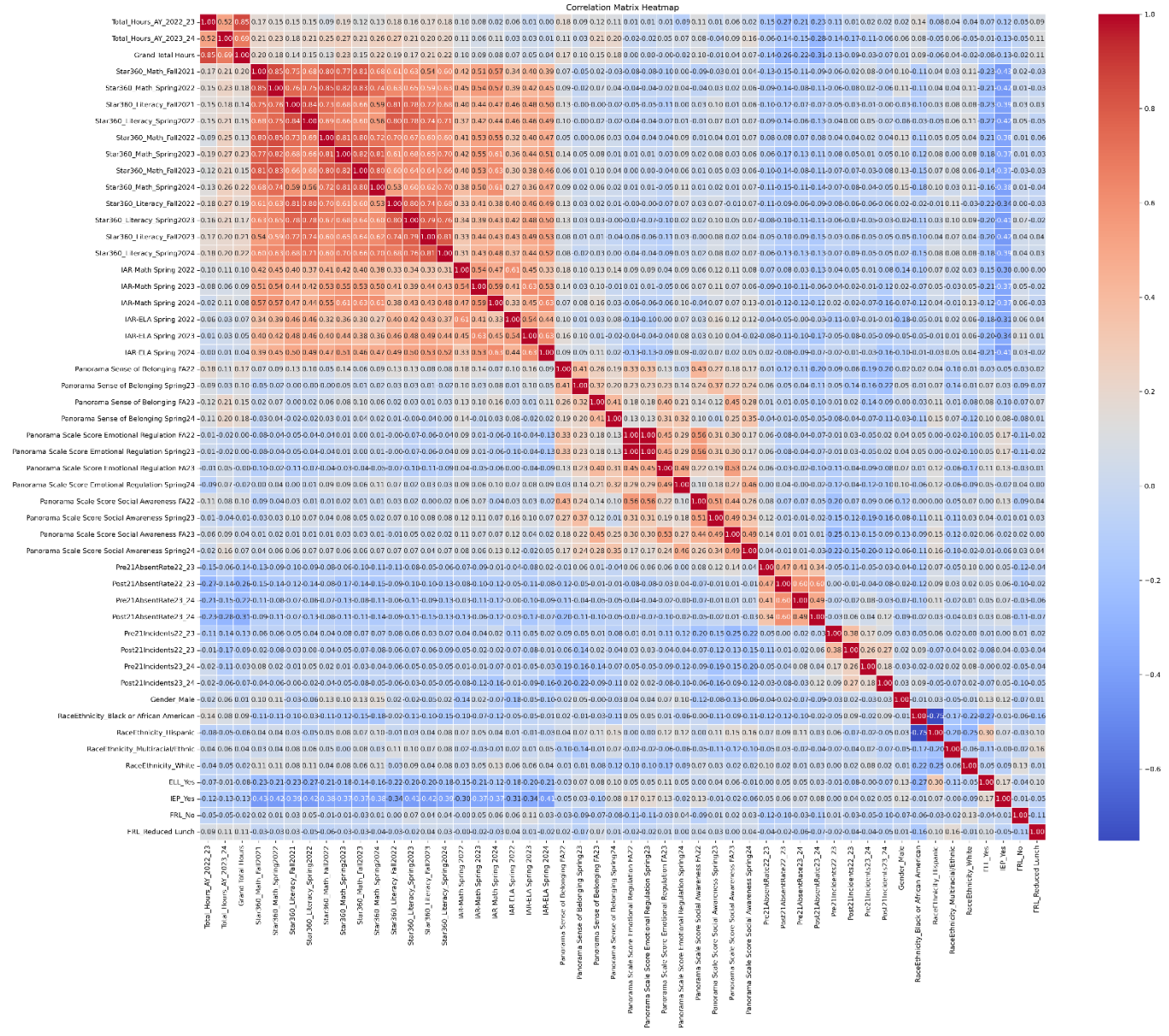


Fig. 3. Correlation Analysis of Key Features

## F. *Exploratory Data Analysis (EDA)*

Descriptive statistics were examined both before and after handling missing values to assess any alterations in key metrics. Comparatively, minimal deviations in means were observed, indicating effective data imputation.

### 1) *Visualization of the Demographics Features:*

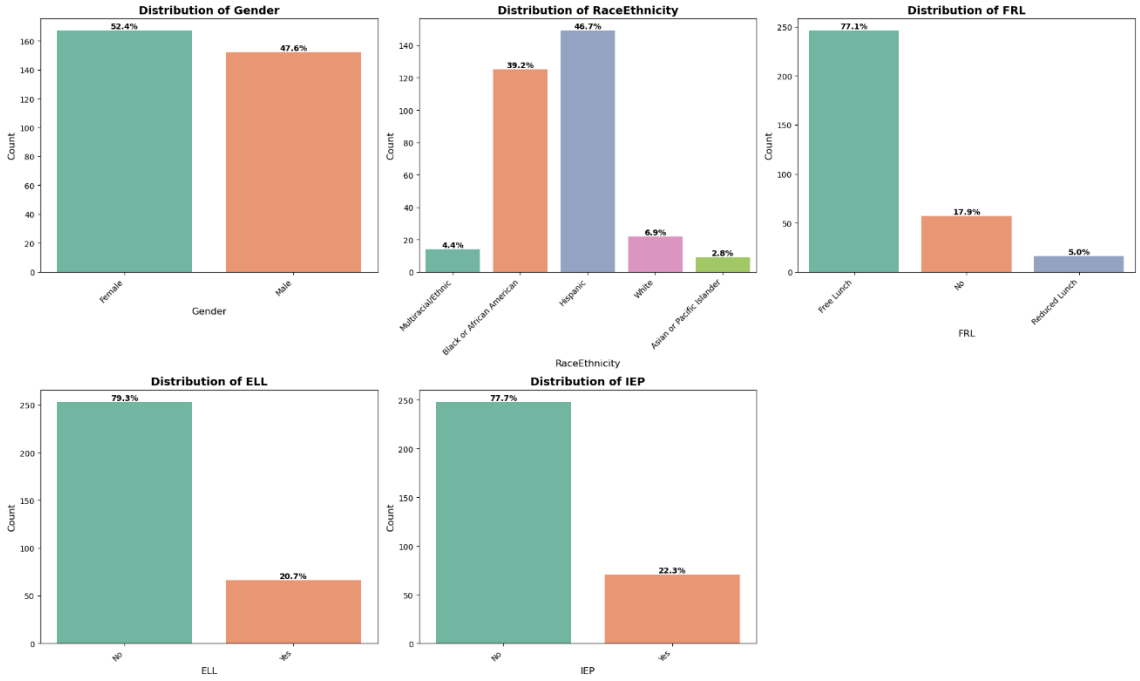


Fig. 4. Bar graph visuals of Demographics Features

2) *Descriptive Statistics of STAR360 Assessments*: Analysis of STAR360 assessments conducted during fall 2022 and 2023, and spring 2023 and 2024, provided insights into students' academic performance in Math and Literacy. Across assessment periods, Math scores showed incremental improvements from fall 2022 (mean ≈ 37.50) to spring 2024 (mean ≈ 41.67), while Literacy scores ranged from approximately 30.08 to 34.28 over the same periods. These findings highlight varying academic achievements and trends among students.

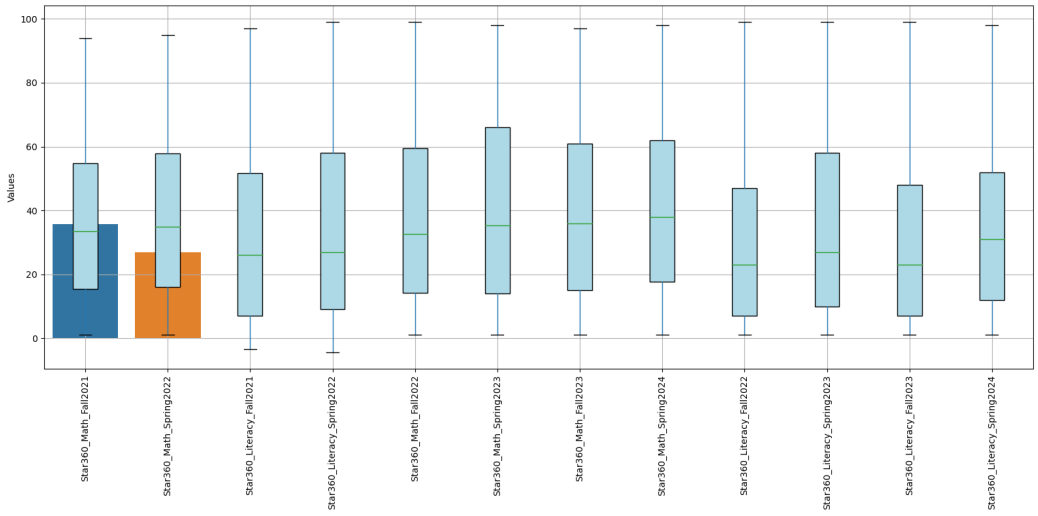


Fig. 5. Descriptive Statistics of STAR 360 Assessments

3) *Descriptive Statistics of IAR Assessments*: The IAR and ELA assessment scores across three academic years consistently involved 320 participants. Mean scores for IAR-Math increased from 2.27 in spring 2022 to 2.53 in spring 2024, with notable variations in standard deviations, particularly in IAR-ELA spring 2024 (SD = 0.99). Minimum scores remained at 1 across assessments, indicating a baseline, while maximum scores varied up to 5, reflecting diverse student achievement levels.

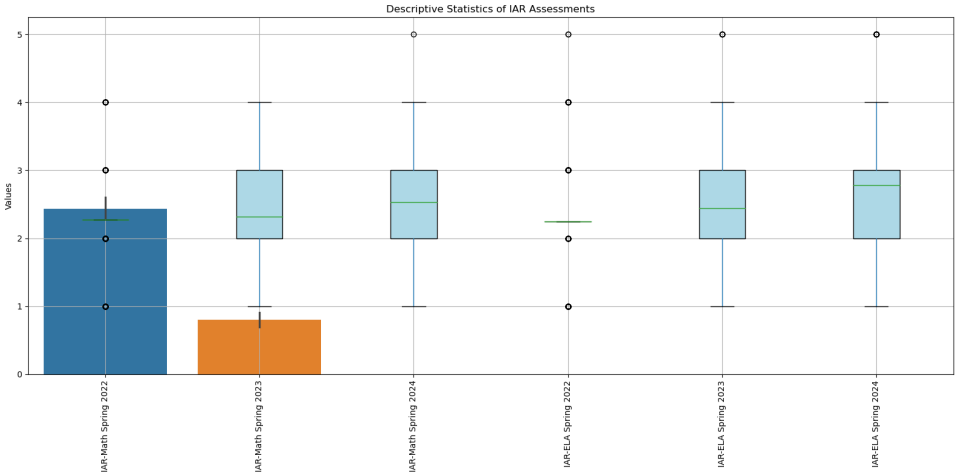


Fig. 6. Descriptive Statistics of IAR Assessments

4) *Descriptive Statistics of Panorama Survey*: Analysis of Panorama survey data from fall 2022 to spring 2024 revealed insights into students' socioemotional well-being. Sense of Belonging scores indicated a positive perception (mean ≈ 3.66 to 3.99), demonstrating consistent community acceptance. Emotional Regulation scores showed moderate to high levels (mean ≈ 3.23 to 3.73), highlighting effective self-regulation. Social Awareness scores remained stable (mean ≈ 3.76 to 3.86), underscoring consistent awareness of social dynamics. These findings underscore students' socioemotional perceptions across the assessment periods.

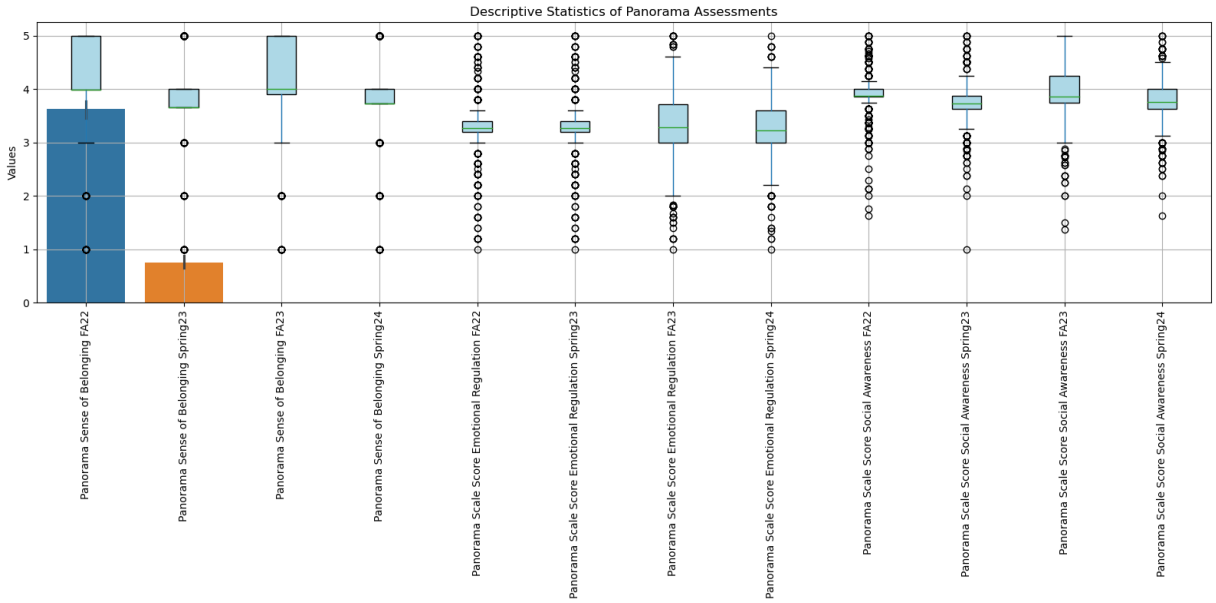


Fig. 7. Descriptive Statistics of Panorama Assessments

# V. MODELING

In this project, we developed two models: a regression model predicting STAR Math Spring 2024 scores and a classifier to categorize IAR-Math Spring 2024 scores into five distinct levels. Both models leverage demographic, academic, and socio-emotional metrics, along with attendance data. After comprehensive data preprocessing, transformation, and feature engineering, we created a new dataframe named standardized_data. This dataset incorporates a diverse array of features crucial for predicting academic performance. Included are academic metrics such as STAR360 Math scores across multiple assessment periods (Fall 2021, Spring 2022, Fall 2022, Spring 2023, Fall 2023, Spring 2024), and IAR-Math scores from relevant periods (Spring 2022, Spring 2023, Spring 2024). Socio-emotional metrics derived from Panorama survey scores, focusing on Sense of Belonging and Emotional Regulation, were also integrated. Demographic metrics, including total hours of program participation across academic years (2022-23, 2023-24), were pivotal components of our analysis.

Features were selected based on correlation analysis and domain knowledge impact on predicting the target variable, IAR-Math Spring 2024 scores categorized into five levels.

*A. Predictive Modeling for STAR360 Spring 2024 Math Scores:* We developed a predictive model to forecast STAR360 Math scores for Spring 2024, leveraging a comprehensive set of demographics, academic, and socio-emotional metrics.

1) *Initial Model Evaluation:* We explored several machine learning models to establish a baseline for performance metrics, including Mean Squared Error (MSE), R-squared (R2), and Mean Absolute Error (MAE). The table below summarizes the results from initial model evaluations using default parameters:

TABLE I
REGRESSION MODELS PERFORMANCE METRICS

| Model | MSE | R2 | MAE |
|---|---|---|---|
| Random Forest | 0.29 | 0.73 | 0.41 |
| KNN | 0.51 | 0.52 | 0.59 |
| SVM | 0.39 | 0.63 | 0.51 |
| Decision Tree | 0.52 | 0.50 | 0.51 |

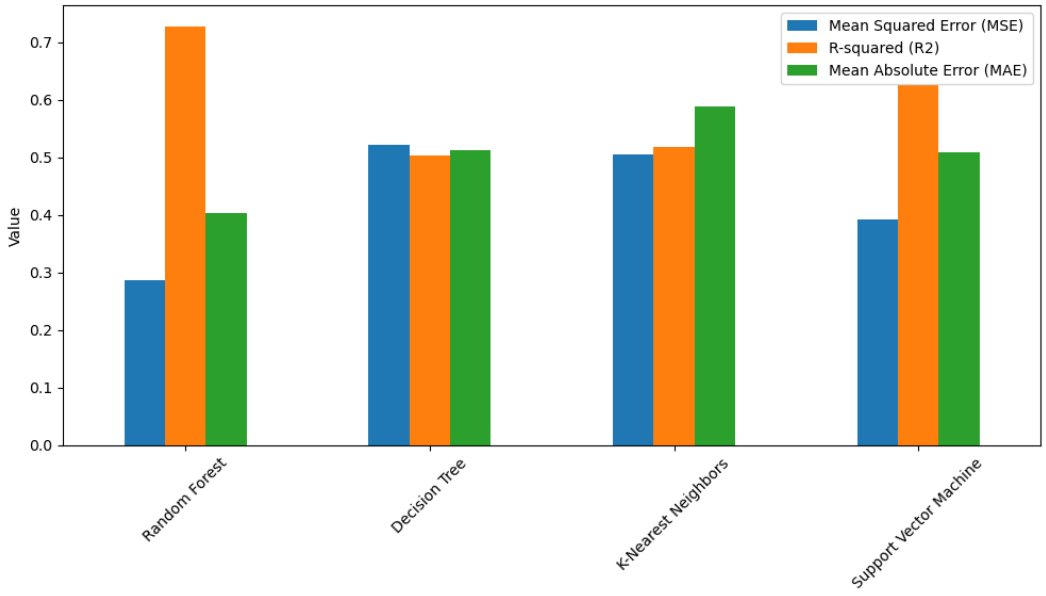


Fig. 8. Regression Model Performance Metrices

2) *Hyperparameter Tuning*: To enhance model performance and ensure its applicability across different datasets, we implemented rigorous hyperparameter tuning techniques including Grid Search and Randomized Search. Our objective was to optimize the predictive accuracy of the Random Forest model. Despite our efforts, the results indicated a slight decrease in performance metrics following tuning. Specifically, the Mean Squared Error (MSE) increased to 0.31, while the R-squared (R2) dropped to 0.70, and the Mean Absolute Error (MAE) rose to 0.44. Despite these outcomes, the process facilitated the selection of robust parameters, enhancing the model's ability to generalize effectively to new data and improving overall predictive capabilities.
3) *Final Model Selection and Validation*: Based on comprehensive evaluations, we selected the Random Forest model as the final predictor for STAR360 Math scores in Spring 2024. This decision was grounded in its superior performance metrics, including MSE of 0.29, R2 of 0.70, and MAE of 0.41. Furthermore, cross-validation procedures validated the model's robustness and reliability across diverse datasets.
4) *Model Interpretation and Insights*: The Random Forest model identified key predictors influencing STAR360 Math scores, highlighting the significance of program participation

hours, demographic characteristics, and academic metrics. Insights derived from feature importance rankings underscored the pivotal role of consistent program engagement in enhancing academic outcomes. Specifically, the analysis shows that STAR360 Math scores are of high importance, followed closely by total hours of program participation. These findings suggest that active participation in the program significantly impacts academic performance, underscoring the importance of both academic and socio-emotional support in student development.

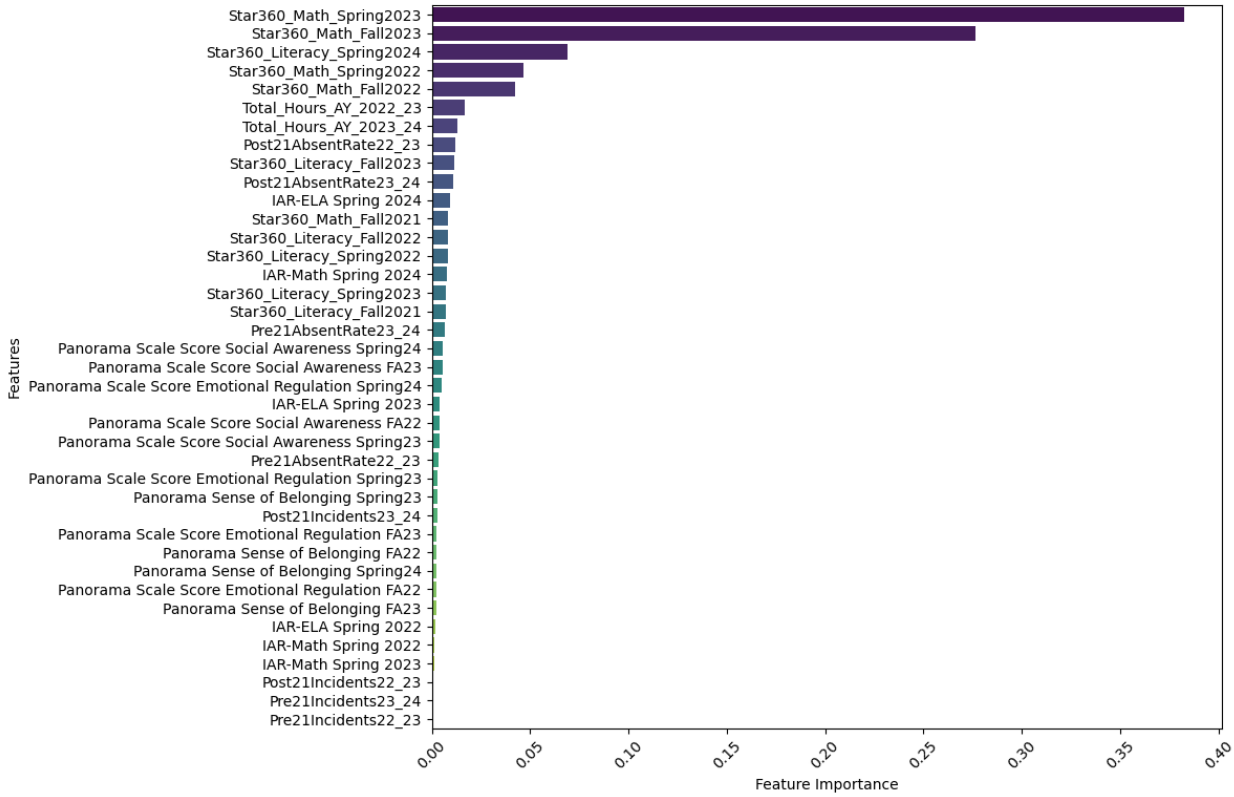


Fig. 9. Random Forest Feature Importance Analysis for Predicting STAR360 Math Scores

This analysis demonstrates how the Random Forest model not only aids in predicting Spring 2024 Math scores based on various variables but also reveals which features play crucial roles in determining academic performance, emphasizing the critical impact of program engagement.

*B. Predictive Modeling for Categorical Levels of IAR-Math Spring 2024 scores*

To predict the performance levels of IAR Math Spring 2024, we evaluated the predictive capability of three distinct machine learning classifiers: Random Forest Classifier, Support Vector

Machine (SVM) Classifier, and Logistic Regression Classifier. These classifiers were chosen for their suitability in handling multi-class classification tasks and their ability to capture nonlinear relationships within the data.

1) *Initial Model Evaluation*: Each classifier was initially trained using default parameters to establish baseline performance metrics, focusing on accuracy and the confusion matrix. This phase aimed to assess the models' initial effectiveness in predicting the five predefined score levels:

TABLE 2
CLASSIFIER MODELS PERFORMANCE METRICS

| Model | Accuracy |
|---|---|
| Random Forest | 93.75% |
| SVM | 81.25% |
| Logistic Regression | 92.19% |

2) *Confusion Matrix Analysis*: Detailed confusion matrices were generated to assess how well each model classified instances into the five predefined score levels, providing insights into model strengths and potential areas for improvement.

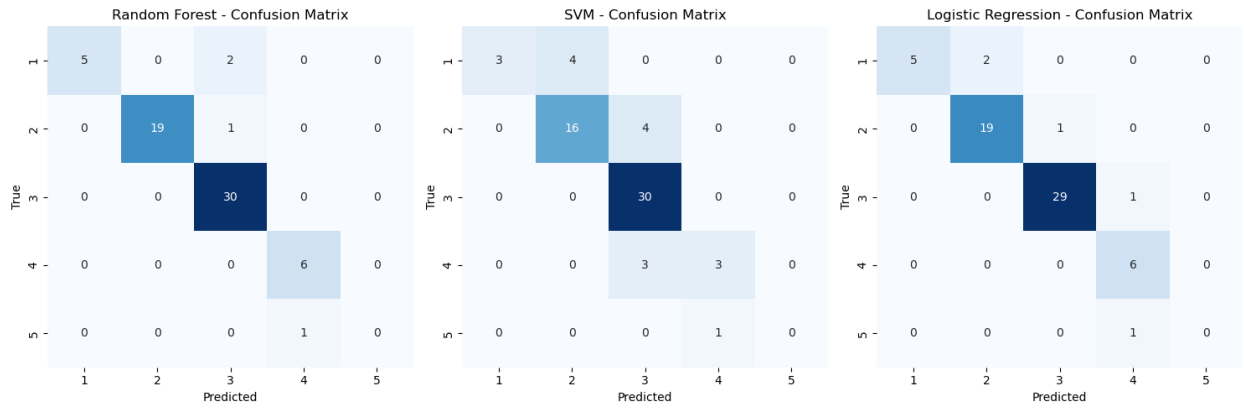


Fig. 10. Confusion Matrix

a. *Random Forest Classifier:* The Random Forest classifier achieved an accuracy of 93.75%. The confusion matrix reveals its effectiveness in predicting the different score levels: This matrix indicates that most predictions were accurate, with some misclassifications mainly between adjacent score levels.

b. *SVM Classifier:* The SVM classifier achieved an accuracy of 81.25%. Its confusion matrix shows: This matrix suggests that while the SVM performed well overall, it struggled more with certain score levels, particularly distinguishing between adjacent categories.

c. *Logistic Regression Classifier:* The Logistic Regression classifier achieved an accuracy of 92.19%. Its confusion matrix is: This matrix indicates good performance across most categories, with slight challenges in correctly classifying a few instances, particularly in the middle score levels.

3) *Hyperparameter Tuning:* Following the initial evaluation where the Random Forest classifier showed promising performance, we proceeded with rigorous hyperparameter tuning using Grid Search with cross-validation (CV=5). This process aimed to refine the model's parameters to enhance its predictive accuracy across different datasets. After comprehensive tuning, the optimal parameters for the Random Forest model were determined: n_estimators of 200, max_depth set to None, min_samples_split of 5, min_samples_leaf set to 1, and max_features using 'sqrt'. Despite the complexities involved, this tuning effort yielded a notable improvement, resulting in the Random Forest model achieving a best accuracy score of 93.73%. This outcome underscores the effectiveness of parameter optimization in maximizing the model's predictive capabilities for forecasting the categorical levels of IAR-Math Spring 2024 scores.

4) *Classification Report:* The classification report for the Random Forest model provides a detailed assessment of its predictive performance on the IAR-Math Spring 2024 scores across five performance levels (1 to 5). It reveals high precision for classes 1, 2, 3, and 4, indicating strong accuracy in classifying instances into these categories. Specifically, classes 1, 2, and 3 achieved perfect precision, signifying that all predicted instances for these classes were correct, while class 4 achieved a precision of 0.8571. The recall scores were also notably high for classes 2, 3, and 4, demonstrating the model's ability to capture true positives effectively in these categories. However, the model faced challenges with class 5, with lower recall and zero precision, suggesting difficulty in correctly identifying instances in this category. Overall, the Random Forest model exhibited an accuracy of 93.75%,

highlighting its robust performance in predicting IAR-Math scores with comprehensive metrics across multiple levels.

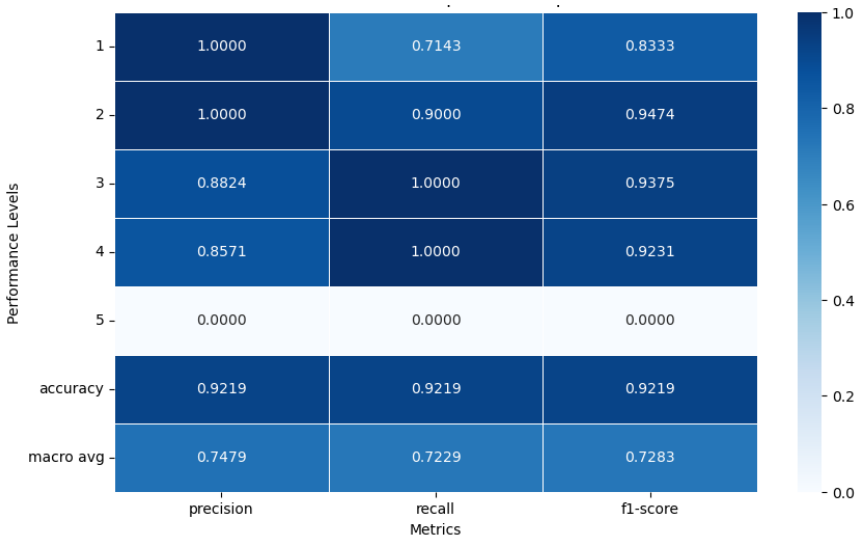


Fig. 11. Classification Report

5) *Feature Importance Analysis:* The feature importance analysis conducted on the Random Forest model identified predictors that significantly influence the IAR Math Spring 2024 scores. The key features identified include IAR scores from previous years and STAR Assessments scores.

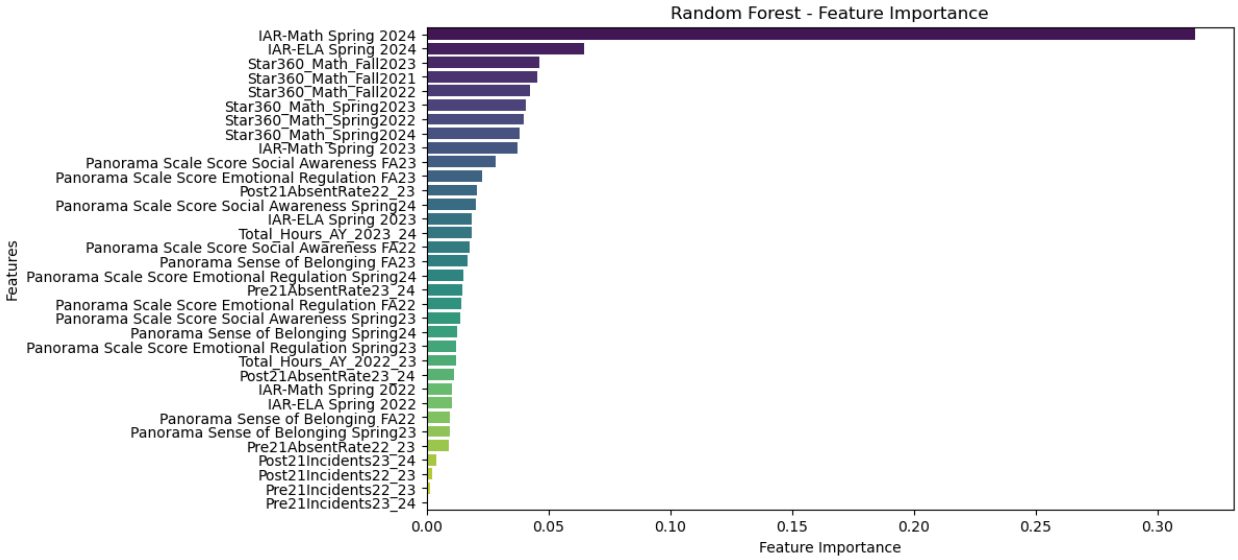


Fig. 12. Random Forest Feature Importance Analysis for Predicting IAR Math 2024 scores

6) *Conclusion:* In conclusion, the Random Forest classifier with tuned hyperparameters demonstrated robust performance with an accuracy of 93.73% in predicting categorical

levels of IAR Math Spring 2024 scores. This model not only outperformed SVM and Logistic Regression but also provided valuable insights into the factors driving student performance. The integration of hyperparameter tuning, detailed confusion matrix analysis, classification report, and feature importance assessment collectively underscore the model's effectiveness and its potential application in educational settings to enhance predictive analytics and student outcomes.

## *VI.* METHODS

To evaluate the impact of various factors on student outcomes, this study employed rigorous statistical methods encompassing hypothesis testing and regression analysis.

### *A. Hypothesis Testing*

To assess temporal changes in student outcomes, paired T-tests were conducted across different metrics. These tests examined significant differences in Star360 and IAR assessment scores between Fall and Spring assessments for academic years 2022-23 and 2023-24. Additionally, t-tests were employed to analyze changes in Panorama scores related to Sense of Belonging, Emotional Regulation, and Social Awareness, as well as variations in absenteeism rates before and after the academic year. The objective was to provide empirical evidence regarding the effects of participation in the 21st CCLC program on academic performance, socioemotional well-being, and attendance.

For each test, confidence intervals were calculated around the mean difference in scores, typically using a 95% confidence level to indicate the range within which the true mean difference in population scores was likely to fall. A significance level (alpha) of 0.05 was adopted, ensuring that results were deemed statistically significant if p-values were less than 0.05. Assumptions of normality and homogeneity of variances were validated to ensure the robustness of the t-test results.

### *B. Regression Analysis of Total Hours and Score Changes*

Regression models were employed to investigate the relationship between Total Hours in Academic Years 2022-23 and 2023-24 and changes in assessment scores. Specifically, models

examined the influence of Total Hours on Star360 Math and Literacy scores from Fall to Spring assessments over multiple academic years, as well as changes in IAR Math and ELA scores from Spring 2022 to Spring 2024.

## VII. RESULTS AND DISCUSSIONS

### *A. Hypothesis Testing*

*The primary hypothesis was:*

1) *H1: Participation in 21st CCLC programs is positively associated with academic performance.*: The analysis of academic assessment scores using paired t-tests aimed to investigate the impact of 21st CCLC program participation on student performance across different academic years. The following significant findings were revealed when comparing the specified variables:

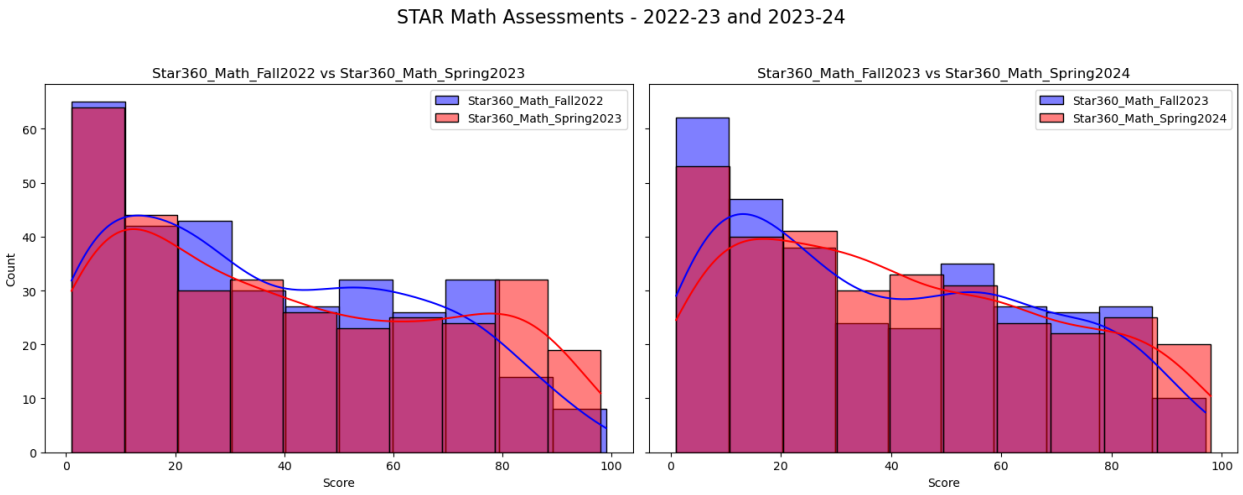


Fig. 13. STAR Math Assessment Distribution Table

a) *STAR360 Math (2022-2023)*: Participants demonstrated a statistically significant improvement in STAR360 Math scores from Fall 2022 to Spring 2023 (t-statistic = -3.31, p = 0.00104), indicating enhanced math proficiency over the academic year.

b) *STAR360 Literacy (2022-2023)*: Participants exhibited a significant improvement in STAR360 Literacy scores during the same period (t-statistic = -4.14, p = 4.52e-05), suggesting positive impacts on literacy skills.

c) *IAR Math and ELA (2022-2023)*: There were no significant differences in IAR Math (t-statistic = -1.26, p = 0.208) and IAR ELA (t-statistic = -4.35, p = 1.82e-05) scores between participants and non-participants from Spring 2022 to Spring 2023, indicating limited program influence on these assessments.

d) *STAR360 Math (2023-2024)*: Participants continued to show significant improvements with a significant increase from Fall 2023 to Spring 2024 (t-statistic = -2.52, p = 0.0123), reflecting sustained positive effects on math proficiency.

e) *STAR360 Literacy (2023-2024)*: Similarly, participants exhibited significant improvement in literacy scores during the same period (t-statistic = -4.08, p = 5.79e-05), highlighting continued positive impacts on literacy skills.

f) *IAR Math and ELA (2023-2024)*: Participants also showed significant improvements in IAR Math (t-statistic = -5.19, p = 3.76e-07) and IAR ELA (t-statistic = -7.24, p = 3.35e-12) scores from Spring 2023 to Spring 2024, indicating notable program effects on these assessments in the subsequent academic year.

These results provide robust evidence supporting Hypothesis 1, indicating that participation in the 21st CCLC program is associated with significant improvements in STAR360 Math and Literacy assessments across multiple academic years. While the impact on IAR assessments was less consistent, significant improvements were observed in the later academic year.

2) *H2: Participation in 21st CCLC programs improves social-emotional wellness.* The investigation into socioemotional wellness using Panorama survey scores yielded the following results:

a) *Social Awareness (Fall 2022 vs Spring 2023)*: Participants showed a significant improvement in Panorama Scale Score for Social Awareness (t-statistic = 4.97, p =

1.10e-06) from Fall 2022 to Spring 2023, indicating positive effects on social awareness. Moving to academic year 2023-2024:

b) *Sense of Belonging (Fall 2023 vs Spring 2024)*: Participants exhibited a significant improvement in Panorama Sense of Belonging (t-statistic = 2.88, p = 0.00423), indicating enhanced feelings of belongingness.

c) *Emotional Regulation (Fall 2023 vs Spring 2024)*: However, there was no significant difference in Panorama Scale Score for Emotional Regulation (t-statistic = 1.38, p = 0.168), suggesting no significant change in emotional regulation over this period.

d) *Social Awareness (Fall 2023 vs Spring 2024):* Participants also showed a significant improvement in Panorama Scale Score for Social Awareness (t-statistic = 3.24, p = 0.00131), indicating continued positive impacts on social awareness.

These findings suggest a mixed impact of the 21st CCLC program on socioemotional wellness. While improvements in social awareness and sense of belonging were observed across different periods, the program's influence on emotional regulation varied, with no significant changes noted in certain assessments.

3) *H3: 21st CCLC program participation is expected to reduce attendance and incident rates among students.*

The analysis of attendance rates demonstrated the following results:

a) *Attendance Rates 2022-23:* There was a significant reduction in absentee rates from pre-program (Pre21AbsentRate22_23) to post-program (Post21AbsentRate22_23) during the academic year 2022-23 (t-statistic = -4.84, p-value = 2.05e-06), indicating that participation in the 21st CCLC program was associated with improved attendance.

b) *Attendance Rates 2023-24*: Similarly, in the academic year 2023-24, participants also showed a significant decrease in absentee rates from pre-program (Pre21AbsentRate23_24) to post-program (Post21AbsentRate23_24) (t-statistic = -6.37, p-value = 6.55e-10), reinforcing the program's consistent positive impact on reducing absenteeism.

These findings highlight the 21st CCLC program's effectiveness in improving attendance rates across different academic years, underscoring its role in promoting regular school attendance among participating students.

4) *H4: The impact of 21st CCLC programs varies significantly by racial identity, ELL status, FRL eligibility, and grade level.*

*a) Students with IEPs*: Significant differences were observed in academic performance (math and literacy) but not in sense of belonging, indicating that IEP status significantly impacts academic outcomes.

*b) ELL Students*: Significant differences were consistently observed in academic performance (math and literacy) but not in sense of belonging, suggesting that ELL status significantly impacts academic outcomes.

*c) FRL Eligibility*: No significant differences were found in academic performance or sense of belonging among different FRL statuses, contradicting the hypothesis.

e*) Race/Ethnicity*: Significant differences in academic performance and occasionally in sense of belonging were observed among different race/ethnicity groups, supporting the hypothesis that racial identity influences academic outcomes to some extent.

For students with IEPs, math scores across all four periods (Fall 2022, Spring 2023, Fall 2023, Spring 2024) are consistently and significantly lower compared to those without IEPs ($p = 0.000$ in all cases), supporting the hypothesis that IEP status significantly impacts academic performance. Similarly, literacy scores for students with IEPs are significantly lower in all four periods ($p = 0.000$). However, no significant differences in the sense of belonging were observed, suggesting that IEP status does not significantly impact students' sense of belonging.

Significant differences in math scores between ELL and non-ELL students are observed consistently across all four periods ($p = 0.000$ or $0.001$), supporting the hypothesis that ELL status significantly impacts academic performance. The same pattern is observed for literacy scores, with significant differences in all four periods ($p = 0.000$ or $0.001$). However, no significant differences in the sense of belonging were found, indicating that ELL status does not significantly impact this aspect.

No significant differences are found in math scores among different FRL statuses in any period, suggesting that FRL status does not significantly impact math scores and contradicting the hypothesis. Similarly, no significant differences are found in literacy scores among different FRL statuses in any period. There are also no significant differences in the sense of belonging, indicating that FRL status does not significantly impact students' sense of belonging.

Significant differences in math scores are occasionally found, particularly for Black or African-American students in Spring 2023, Fall 2023, and Spring 2024, and for Asian or Pacific Islander students in Fall 2023. Literacy scores show significant differences occasionally, particularly for Black or African-American students in Spring 2023 and Spring 2024. Similarly, significant differences in the sense of belonging are found occasionally, particularly for Asian or Pacific Islander students in Fall 2023 and Black or African-American students in Spring 2024.

In summary, the analysis strongly supports the hypothesis that IEP status impacts academic performance (math and literacy) but does not impact the sense of belonging. It also supports the hypothesis that ELL status impacts academic performance (math and literacy) but not the sense of belonging. However, the analysis does not support the hypothesis that FRL status impacts academic performance or the sense of belonging consistently. Regarding race/ethnicity, the findings provide partial support for the hypothesis, with some significant differences observed, particularly for Black or African-American students and occasionally for Asian or Pacific Islander students.

### *B. Regression Analysis of Total Hours and Score Changes*

Regression analyses examined the relationship between Total Hours in the Academic Years 2022-23 and 2023-24 and score changes:

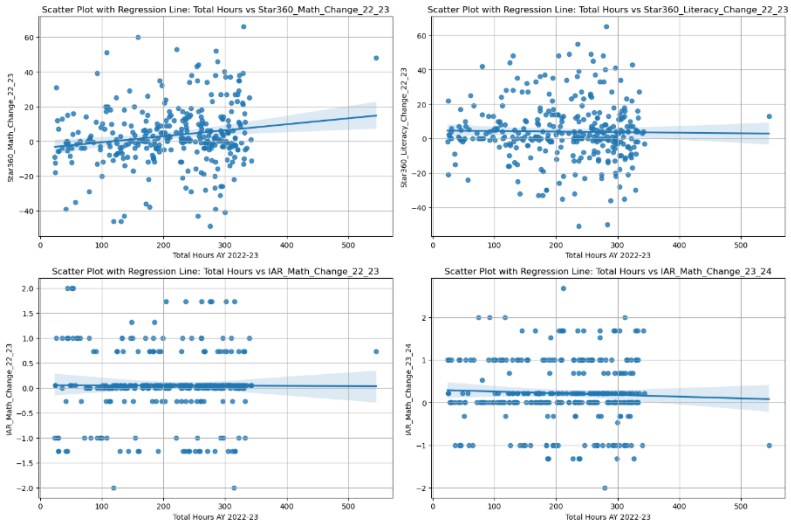


Fig. 14. Scatter Plot Depicting the Relationship Between Total Participation Hours and Changes in Assessment Scores in 2022_23

1) *STAR360 Math Change 22-23:* A significant positive relationship was found (coef = 0.0345, p = 0.002), indicating that an increase in hours during this period was associated with improved STAR360 Math scores.
2) *STAR360 Literacy Change 22-23:* No significant relationships were observed (p = 0.762), nor for any changes in IAR Math scores across the examined periods (p > 0.05).

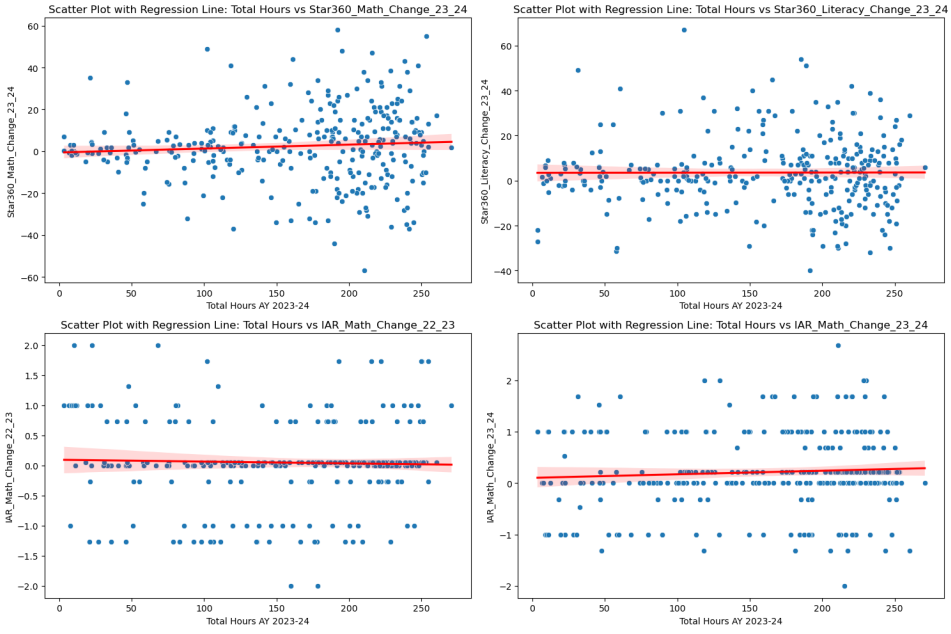


Fig. 15. Scatter Plot Depicting the Relationship Between Total Participation Hours and Changes in Assessment Scores in 2023_24

3) *STAR360 Math Change 23-24 and STAR360 Literacy Change 23-24*: No significant relationships were found ($p > 0.05$).

These results suggest that while Total Hours may positively influence STAR360 Math scores in specific periods, no significant relationships were found for STAR360 Literacy or IAR Math scores across the examined periods.

## *VII.* ETHICAL CONSIDERATION

In conducting this study on the impact of the 21st CCLC program on students' academic performance, socio-emotional wellness, attendance, and incidents, several ethical considerations were rigorously addressed to ensure the integrity of the research and the protection of participants' rights and privacy.

### *A. Privacy Protection*

1) *Data Anonymization*: To safeguard the identities of participating students, all personal identifiers such as names and student IDs were removed from the dataset. Data anonymization techniques were employed to ensure that individual students could not be identified from the analysis or reporting of results.
2) *Data Security*: The data were securely stored on 21st CCLC storage devices with restricted access limited to authorized personnel only. Encryption protocols were rigorously implemented to safeguard data integrity and confidentiality both at rest and during transmission, thereby protecting against unauthorized access.

### *B. Informed Consent*

1) *Consent from Participants:* Prior to participation, informed consent was obtained from both students and their guardians. Consent forms clearly outlined the study's purpose, the nature of data collection, and how the data would be used. Only students whose guardians provided consent were included in the study, ensuring voluntary and informed participation.

### *C. Ethical Responsibilities of Researchers*

1) *Confidentiality*: Researchers upheld strict confidentiality standards throughout the study. Findings were aggregated and reported in a manner that prevented the identification of individual students. This commitment to confidentiality helped build trust with participants and their families.

2) *Bias and Objectivity*: Measures were taken to maintain objectivity in all stages of the research process. Standardized data collection procedures were implemented, and robust statistical methods were used to analyze the data objectively. Personal biases were consciously minimized to ensure impartiality in interpreting the research outcomes.
3) *Transparency and Accountability*: The research methodologies, data handling procedures, and analytical techniques were transparently documented. Limitations and potential biases were openly acknowledged in the reporting of findings, ensuring accountability and facilitating reproducibility by other researchers.

By adhering to these ethical principles, this study aimed to produce scientifically rigorous findings while respecting the rights, privacy, and well-being of all participants. These practices are essential for maintaining the trustworthiness and credibility of the research outcomes, which can inform educational policies and practices effectively.

## IX. CONCLUSION

The comprehensive analysis conducted in this study underscores the substantial benefits of 21st Century Community Learning Centers (21st CCLC) programs on student outcomes across academic performance, socioemotional wellness, attendance, incidents, and the relationship with total participation hours.

### *A. Academic Performance*

The study found compelling evidence of the positive impact of 21st CCLC programs on academic performance, particularly in core subjects like STAR360 Math and Literacy. Participants demonstrated significant improvements in these assessments over multiple academic years, indicating that the structured enrichment activities and academic support provided by the programs contribute to enhanced proficiency in key academic areas.

### *B. Socioemotional Wellness*

Beyond academic outcomes, the programs also showed positive effects on socioemotional development. Participants reported improved social awareness and a stronger sense of belonging, reflecting the programs' success in fostering supportive environments conducive to holistic student growth. However, variability in outcomes, particularly in emotional regulation, suggests potential areas for targeted intervention and further refinement of program strategies.

*C. Attendance and Incidents*

Significant reductions in absenteeism were observed among program participants across different academic years. This finding highlights the programs' role in promoting regular school attendance, a critical factor in academic success and overall student well-being. Moreover, there were notable decreases in behavioral incidents, underscoring the programs' positive influence on maintaining a conducive learning environment.

*D. Total Hours and Score Changes*

While no significant relationships were found between total participation hours and improvements in STAR360 Literacy or IAR Math scores across all examined periods, except for a significant positive relationship observed in STAR Math scores in Fall 2022, the study underscores the importance of evaluating and potentially adjusting program components to optimize outcomes in these areas. This highlights potential areas for program refinement or targeted support to ensure comprehensive academic support across all subject areas.

## X. RECOMMENDATIONS

Building on these findings, several recommendations are proposed to maximize the impact of 21st CCLC programs:

A. *Enhanced Program Integration*: Strengthening the integration of academic enrichment activities within the programs can further bolster their effectiveness in improving STAR360 Math and Literacy scores.
B. *Targeted Socioemotional Support*: Implementing targeted interventions to enhance emotional regulation skills could address variability in socioemotional outcomes and promote comprehensive student development.
C. *Continuous Evaluation and Adaptation*: Establishing a robust monitoring and evaluation framework to regularly assess program outcomes, including attendance, incidents, and academic progress, will provide ongoing insights for program refinement and adaptation.
D. *Promotion of Equitable Access*: Ensuring equitable access to program benefits for diverse student populations, including those with varying academic needs and backgrounds, is crucial. Tailored support for students with IEPs, ELLs, and from different socioeconomic backgrounds can further enhance program effectiveness and inclusivity.

By implementing these recommendations, educational stakeholders can capitalize on the proven benefits of 21st CCLC programs to foster academic achievement, socioemotional well-being, and overall student success across diverse school settings.

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