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The Impact of Teacher, School, and Student Factors on Standardized Student Test Scores Using Multidimensional Approach

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ABSTRACT

This study examines the effect of teacher (race, salary, and experience), school (climate and Financial Efficiency Star Rating), and student (attendance and mobility) factors on student Math and ELA standardized test scores in elementary (n = 1140) and middle (n = 451) public schools across the state of Georgia. The data used in this study was collected by Georgia Department of Education (GaDOE) during the 2018-2019 school year. Three multivariate linear regression models are utilized to explore the main and interaction effects within and between factors. The first model analyzes the main effects of the three independent variables (teacher, school, and student) separately and then in a single combined model accounting for all factors. Individual model approach reveals strong positive correlations with Math and ELA test scores for all factors. However, the impact of each factor is greatly diminished in a combined model approach. The second model reveals that the interaction effects within factors does not impact student test scores significantly. Meanwhile, results from the third model show that the interactions between the three independent variables yield a modest impact on student test scores. Findings from this study can guide educators and policymakers to focus on factors that can improve student standardized test scores and meet the accountability mandate for school achievement as set by the Every Student Succeeds Act (ESSA) of 2015 and its predecessor No Child Left Behind (NCLB) Act of 2001.

Keywords: Academic Achievement, Multivariate Linear Regression, School Resources, Standardized Testing, Teacher Quality

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I. Introduction

In the state of Georgia, students in grades 3 through 8 must take the Georgia Milestone tests, an end-of-grade (EOG) summative assessment, in the content areas of ELA, math, science, and social studies (Georgia Department of Education, nd). The Georgia Milestone Assessment System (GMAS) was implemented in 2015 and replaced the retired Criterion-Referenced Competency Tests (CRCT), which the State used for 15 years. The GMAS tests are more meticulous and demanding than CRCT tests (Price, 2019). They are constructed to challenge students beyond simply choosing one correct answer from a multiple choice. In some cases, students must find the correct answer themselves rather than selecting it. In other cases, students must explain how they got their answers or yet why a given answer is wrong. Third grade students must pass ELA to move to fourth grade whereas fifth and eighth grade students must pass ELA and math subjects to move to the next grade (Georgia Department of Education, nd). The GMAS tests are designed to challenge schools, teachers, and students to study the core subjects for the duration of the school year. They are not the type of tests where students can simply get by if they only spend a short period of time preparing prior to the tests, especially for questions where students are required to provide writing responses (Price, 2019). The GMAS tests are adopted from the national Common Core State Standards (CCSS) initiative of 2009, which guides what students should learn in each grade level. As such, the test results are intended to be used by parents, educators, policymakers, and the public in general as an indicator of the efficacy of the educational system at the school and school district level in the state of Georgia (Tagami,2016). In 2019, the State of Georgia was ranked significantly lower than National average score in Math and Writing and at the national average in Reading for Grade 4 (National Assessment of Educational Progress, n.d.).

II. Literature Review

Traditionally, summative assessments are used to sort and promote students based on their test scores. Some researchers have argued that the dependence on summative assessment

practices via standardized tests will not close the achievement score gaps (Chappuis *et al*., 2020; Orlich & Gifford, 2006). Recent educational reform policies added immense pressure on schools and teachers to produce higher test scores. Schools and teachers whose students scored low are labelled as "failed" schools and either punished or put on probation, whereas teachers and schools whose students scored high are generally rewarded (Newton, 2017; Darling-Hammond, 2004). As such, educators must be compelled to research factors that contribute to this disparity. In fact, identifying the multifaceted factors that can advance student learning outcomes continues to be a topic of high interest in academic research at both the national and state levels. Consequently, a considerable body of work centered around school, teacher, and student factors has emerged (Cirino *et al*., 2018; Orlich, 2003).

One factor in question when dealing with students' test scores is teacher quality. Prior research has mostly shown a positive correlation between teacher quality and student achievement (Hanushek, 2018; Dial, 2008). However, the relation between the two is complex and provokes controversy and debate amongst various education stakeholders (Goldhaber, 2008; 2015). The impact of teacher quality on student test scores and achievement spans a continuum of variables such as experience, compensation, licensure, race, and professional development. While considerable number of prior research concluded that teacher experience and mastery in pedagogy can yield gains in student learning and performance, others disputed these findings (Weaver, 2019; Ladd, 2008). Ladd (2008) determined that teachers with 20 years of experience have more impact on student learning than first year teachers, but the impact disappears when compared to teachers with 5 years of experience. Hightower *et al*. (2011) concluded that teacher experience resulted in positive gains on student learning and their scores on standardized tests. Other studies have shown that other factors such as teacher preparation programs, training, and attrition of teachers may eclipse the advantage of teacher experience (Xu *et al*., 2011; Boyd *et al*., 2008). These contradicting conclusions raise questions whether teacher experience by itself a positive contributor to students is test scores or rather an interaction with other contributing factors. Furthermore, disparity in teacher salary compared to other professions has gathered substantial support in the political and public arena. In recent years, a growing number of research was conducted to address the effects of teacher salary on student academic outcomes (Pham *et al*., 2020; Loeb & Page, 2000). Pham *et al*. (2020) conducted a meta-analysis of 44 studies that addressed this topic. They determined that teacher salary had a small positive effect on student test scores. Moreover, many studies have shown that there is inequitable representation of minority teachers in public schools (Yarnel & Bohrnstedt, 2018; Clotfelter *et al*., 2005). While prior research has shown that students could academically benefit and their test scores could be improved when they share the same race/ethnicity with their teachers, the imbalance between White and minority teachers still largely exists. This imbalance has provoked an outcry from policymakers at the national and state levels demanding public schools to recruit, hire, and train minority teachers (Joshi *et al*., 2018; Partelow *et al*., 2017).

A second factor that prior research studied its effect on student achievement is school characteristics. Researchers have explored many school inputs and the magnitude of their relations on student achievement. Some of these inputs included student/teacher ratios, expenditures per student, school resources, cultural diversity, leadership, and school environment (Ntobeko, 2018; Savasci & Tomul 2013.) The findings from such growing body of research were mixed. For example, some studies concluded that there is no significant effect of expenditures per student on test scores. Hanushek (1998) concluded that there is no positive relation between school expenditure and student academic achievement. He argued that due to inefficiencies in school operation increase in expenditures does not necessarily yield better student outcomes. On the other hand, other studies (Jackson *et al*., 2016; Sun, 2014) determined that school expenditures have positive effect on student educational outcome. School environment has also been studied by prior research with a general consensus that school environment positively affects academic achievement and is a leading factor in explaining student test scores and learning (Dulay & Karadağ, 2017; Jimenez-Castellanos, 2010). The findings from such growing body of research should guide policymakers to allocate school funding according to school quality and performance. Parents are inclined to search for better schools for their children, and hence to move to school districts that offer safe environment and generate more tax revenue to support student education (Ostrander, 2015).

A third factor of a great concern for school administration regarding its impact on test scores is associated with students' attributes. Some of these attributes include attendance, mobility, race, socio-economic status, English proficiency, and special needs students. For instance, attendance has long been considered as a key contributor to student achievement and success. The research on this topic has increased in recent years due to school accountability and NCLB legislation (Kim, *et al*., 2020; Cassell, 2019). Several studies have shown a strong positive link between student attendance and academic performance and graduation rates (Gershenson, 2016; McGahee, 2019; Gottfried, 2010). In addition, student mobility has been studied by prior research with contradicting conclusions. Student mobility has been linked to poor student performance in ELA, Math, and Reading (Sparks, 2016; Eddy, 2011). It has also been determined that student mobility has a detrimental impact on both students and their schools (Rhodes, 2005). Conversely, other research argued that such impact might not be related to student mobility by itself but rather to an interaction with other factors such as socio-economic status, cultural background, and family structure (Donnelly & Gamsu, 2018; Welsh, 2017). As family mobility continues to be a major issue in the American society, students are forced to make the proper adjustments (Welsh, 2016). These students normally do not receive the proper attention at school to address the psychological impact of mobility on their academic and social well-being. Teachers tend to spend more time and focus on addressing the needs of the less mobile students since such needs are much more manageable (Eddy, 2011).

III. Present Study

The purpose of this study is to investigate the impact of factors associated with teachers, schools, and students on the overall GMAS Math and ELA test scores in elementary and middle schools across the state of Georgia during 2018-2019 school year. Students attending 3rd through 8th grades in the state of Georgia are required to take end-of grade tests in the content areas of ELA, Math, Reading, and Social Studies. Each school can select a time period as designated by the State, normally towards the end of school year, to administer these tests. Students can attain the following four achievement levels for each test (Georgia Department of Education, nd):

1) Beginning Learner – Student lacks basic knowledge in content area as required by Georgia's content standards and requires considerable support to be ready for next grade level.

2) Developing Learner – Student demonstrates partial knowledge in content area as required by Georgia's content standards and requires further academic support to be ready for next grade level.

3) Proficient Learner – Student exhibits proficiency in the knowledge needed at this grade level and is prepared for the next grade level.

4) Distinguished Learner – Student demonstrates mastery in the knowledge needed at this grade and is well prepared for the next grade level.

While significant body of research has examined the effects of various variables on student learning and achievement, most of these studies focused on only one variable at a time. The current study offers a more comprehensive approach that accounts for three main independent variables and multiple factors associated with them. Identifying the impact of multifaceted variables and their interaction on standardized test scores is particularly important to the academic development of young students and improvements in school achievement and teacher quality. Research has shown that the impact of such variables can be more profound in the academic development of middle school students. These students are at a higher risk of dropping out from high school at later years if they are not performing well (Balfanz, 2007). Moreover, findings from this study can contribute to the continuous improvement push in public education as mandated by various national and state legislations such as the ESSA Act of 2015 and its predecessor NCLB Act of 2001.

IV. Conceptual Framework

The conceptual framework for this study is beneficial since it addresses three important conceptual components in elementary and middle schools: (1) the individual relationship between teacher, student, and school factors on student test scores in Math and ELA, (2) the combined impact of teacher, student, and school factors on student test scores in Math and ELA, and (3) the interaction within and between variables. The framework (Fig. 1) is modeled and refined based on prior research findings and the gap in literature that this study is aiming to address by examining the following research questions:

1) To what extent are students test scores in Math and ELA affected by teacher factors (salary, race, and experience)? school factors (climate and FESR rate)? student factors (attendance and mobility rate)?

2) To what extent are students test scores in Math and ELA affected by the combined teacher, school, and student factors?

3) Are there any significant interaction effects within teacher, school, and student variables on student test scores in Math and ELA?

4) Are there any significant interaction effects between teacher, school, and student variables on student test scores in Math and ELA?

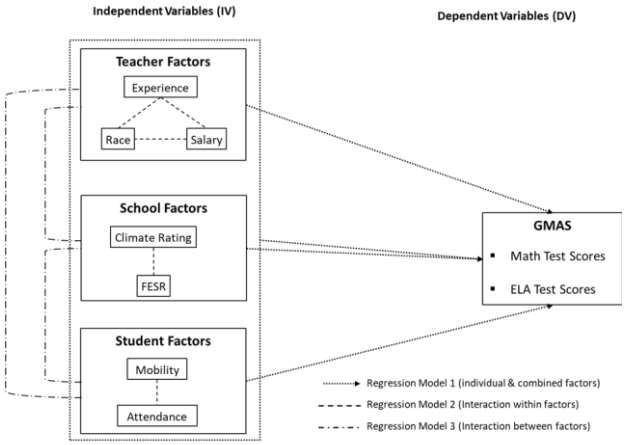

Fig. 1. Conceptual framework.

V. Method

A. Participants

The population for this study consists of all elementary and middle public schools in the state of Georgia during 2018-2019 academic year (n = 1140 for elementary schools and n = 451 for middle schools). The data sources for this study were downloaded from the following websites:

1) Georgia Department of Education (GaDOE): https://www.gadoe.org/Pages/Home.aspx

2) The Governor's Office of Student Achievement (GOSA): https://gosa.georgia.gov

3) There are missing data for 10 elementary schools and 6 middle schools. These schools are dropped from the analyses since the number of missing data is significantly small compared to the total number of public schools in the state of Georgia. The following reports for 2018-2019 academic year are used as basis for analyses in this study:

4) School Score Report Card: GMAS End-of-Grade (EOG) report that tracks student test scores disaggregated by performance levels, student attributes, and grade level for each content area.

5) Certified Personnel Data file: Tracks teacher data related to gender, race, salary, experience, education, and certification.

6) School Climate Rating: This data set includes multiple distinct constructs and comes from diverse sources such as surveys, student records, teacher records, safe environment, substance free, student perception, parent perception, and personnel perception.

7) School Financial Efficiency Star Rating (FESR): The purpose of this star rating is to provide school spending per student as it relates to academic performance of students averaged over a three-year period. The school rating is based on College and Career Ready Performance Index (CCRPI) and per pupil expenditure (PPE) calculations.

8) Student Attendance: Data are provided by school districts to GaDOE each year using student record.

9) Student Mobility: Data is collected by GaDOE based on the percentage of students admitted or withdrew from a school during one academic year.

B. Measures and Procedures

Quantitative methods are used to analyze the collected data from GaDOE and GOSA websites. Exploratory research is utilized to identify key teacher, school, and student factors that contribute to student test scores in Math and ELA. This study is also correlational in nature since it attempts to determine relationships between multiple variables as they relate to student test scores. Three multivariate linear regression models are used for two content areas, Math and ELA. The first model explores the main effects of three independent variables (Teacher, School, and Student) on the dependent variable (student test scores). The second regression model explores the interaction effects within each independent variable on student test scores while the third regression model explores the interaction effects between independent variables. For the second and third regression models, the factors for each independent variable are standardized (centered) by subtracting the mean value. To run a regression model analysis with interactions, new factors are created by multiplying the standardized factors within each independent variable for the second model and across independent variables for the third model. Finally, scaled measures are created for the following factors for a better interpretation of the results:

1) Teacher Factors

The "Certified Personnel Data" report divides teachers' years of experience in 5 subgroups: <1 year, 1-10 years, 11-20 years, 21-30 years, and >30 years. Table I shows an example calculation for a random school in order to determine its Teacher Experience Rate score. Similar calculation is used for all elementary and middle schools. Since the majority of elementary and middle school teachers in the state of Georgia are White, a race score scale is established according to the percentage of White teachers in each school. The following rate scale is used for each school:

- 0% - 25% = 1 (very low White teacher percentage);
- 25.1% - 50% = 2 (low White teacher percentage);
- 50.1% - 75% = 3 (high White teacher percentage);
- 75.1% - 100% = 4 (very high White teacher percentage).

The teacher salary ranges between $40k to $70k per year. A salary scale is used according to the following:

- $40,000 - $50,000 = 1;
- $50,001 - $60,000 = 2;
- $60,001 - $70,000 = 3.

2) School Factors

The Star Climate and FESR reports are available at the state, district, and school level. The Star Climate report assesses and grades each individual climate factor separately. An overall scale of 1 – 5 is then used to rate each school, where 1 Star is given to schools in need of most improvement and 5 Stars to schools having an excellent climate. The FESR report uses a scale of 0.5 to 5 stars in 0.5 intervals where a rating of 0.5 Star is given to a school with high spending and low CCRPI and a rating of 5 Stars is given to a school with low spending and high CCRPI (Georgia Department of Education, nd).

3) Student Factors

The Student Attendance report includes data at the district and school levels showing the percentage of students' absenteeism in 3 distinct levels:

- 0 – 5 days (Exemplary);
- 6 – 15 days (Acceptable);
- >15 days (Unacceptable).

Table II shows an example calculation for a random school in order to determine its Attendance Rate score. Similar calculation is used for all elementary and middle schools.

The Student Mobility report is also available at the state, district, and school level. The state of Georgia defines a student as mobile if he or she enters or withdraws from school between October 1st and May 1st (Georgia Department of Education, nd). The data in the report ranged between 2 and 63. The following Mobility Rate Score scale is created for the purpose of analysis:

- < 5 = 5 (very low mobility rate);
- 5.1 -10 = 4 (low mobility rate);
- 10.1 - 20 =3 (average mobility rate);
- 20.1 - 40 = 2 (high mobility rate);
- 40 =1 (very high mobility rate).

TABLE I: SAMPLE CALCULATION OF TEACHER EXPERIENCE RATE SCORE

Years of Experience (YOE)	Adjusted YOE (AYOE)	Number of Teachers (#TEACH)	Scaled Score (SS) = AYOE x #TEACH	Average Experience/Teacher =SS/#TEAC	Experience Rate Score
<1	1	1	1		
1-10	5	11	55		
11-20	15	21	315		
21-30	25	9	225		
30	30	3	90		
Total Score		45	686	15.24	2

Note: Rating scale: Low experience (1) 9.00-14.00, Moderate Experience (2) 14.01-19.00, High Experience (3) 19.01-24.00.

TABLE II: SAMPLE CALCULATION OF STUDENT ATTENDANCE RATE SCORE

% Absent (0-5 days)	Scaled Absence (0-5 days)	% Absent (6-15 days)	Scaled Absence (6-15 days)	% Absent (>15 days)	Scaled Absence (>15 days)	Scaled School Absence (6-15 days)	Student Attendance Rate
59.6	149	36.2	380.1	4.2	63		
Total Score						592.1	4

Note: Rating scale: Very Low Attendance (1) 801-1000, Low Attendance (2) 701-800, Moderate Attendance (3) 601-700, High Attendance (4) 501-600, Very High Attendance (5) 300-500.

4) Math and ELA Test Score Measures

The End-of-Grade (EOG) Assessment's report is used by this study to extract data in relation to how well students are mastering content standards in Math and ELA. The report disaggregates the data by grade level and the percentage of students in each achievement level (Beginning, Developing, Proficient, Distinguished). For the purpose of this study, the Subject Test Score Rate (STSR) for each individual school is calculated according to the following formula:

$$STSR = \%\ Beginner \times 1 + \%\ Developing \times 2 + \%\ Proficient \times 3 + \%\ Distinguished \times 4 \quad (1)$$

C. Data Analysis

SPSS software is used for descriptive and multivariate inferential analysis using multiple linear regression models. The analyses are done to determine if the student test scores in Math and ELA can be predicted from teacher factors (salary, race, and experience), school factors (climate and FESR rate), and student factors (attendance and mobility rate). The assumption of normality is tested and met via examination of the unstandardized residuals for all regression models. Review of the S-W test for normality, skewness, and Kurtosis suggest that the normality is a reasonable assumption. The boxplots suggest a relatively normal distributional shapes with no outliers of the residuals. The Q-Q and histogram plots for all regression models also suggest that normality is reasonable. The data are tested for homogeneity of variances using Levene's test and the assumption of homogeneity is satisfied. Examination of casewise diagnostics including Mahalanobis distance, Cook's distance, DfBeta values, and centered leverage values to determine multivariate outliers suggest there are no cases exerting undue influence on any of the regression models. Finally, the data are tested for mutlicollinearity to examine if two or more variables are highly correlated. A Variance Inflation Factor (VIF) of 10 is used as a critical value to determine if variables are highly correlated. Results show no evidence that multicollinearity is an issue.

VI. RESULTS

A. Descriptive Statics

Table III shows the basic descriptive results for the dependent and independent variables. The results show that most of the teachers in elementary and middle schools are White with an average salary of $50k - $60k per year and an average experience between 11–20 years. The average Climate Star rate is relatively high for both elementary (M = 3.96) and middle (M = 4.01) schools, generally indicating good schools' environment and a positive perception by various education stakeholders about public schools in the state of Georgia. The average FESR rate is slightly higher for middle schools (M = 3.20) than elementary schools (M = 2.83), indicating on average that the State spends more money per middle school student than elementary school student. However, the results do not tell us if spending per student is distributed differently based on demographics, socio-economic status, or school environment and achievement. Student attendance and mobility score results are average on both scales for elementary and middle schools. On average, mobility rate is slightly higher for middle schools (M = 3.00) than elementary schools (M = 2.77). The Subject Test Score Rate (STSR) for elementary schools ranges between 146-366 for Math and between 138-352 for ELA, whereas STSR for middle schools ranges between 126-341 for Math and between 144-333 for ELA.

TABLE III: DESCRIPTIVE STATISTICAL RESULT FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	Elementary			Middle		
	M	SD	n	M	SD	n
Math Score	238.46	40.26	1140	225.47	40.19	451
ELA Score	229.60	41.03	1140	223.92	36.44	451
Salary	2.14	0.54	1140	2.13	0.57	451
Race	3.20	1.12	1140	3.01	1.18	451
Experience	2.05	0.45	1140	1.98	0.45	451
Climate	3.96	0.90	1140	4.01	0.89	451
FESR	2.83	0.93	1140	3.20	0.97	451
Attendance	2.72	0.85	1140	2.67	1.04	451
Mobility	2.77	0.83	1140	3.00	0.78	451

Note: Dependent Variables: Math Score, ELA Score.
Independent Factors: Salary, Race, Experience, Climate, FESR, Attendance, Mobility

B. Multivariate Linear Regression - Model 1

Model 1 attempts to predict both the individual and combined main effects of teacher, school, and student factors on student subject test scores in Math and ELA. The relationships between teachers' individual factors (salary, race, and experience) and Math and ELA test scores for elementary schools are significant at 5% confidence level ($p < 0.05$, Table IV).

TABLE IV: RELATIONSHIP COEFFICIENTS BETWEEN TEACHER FACTORS AND SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	127.6*	5.38		23.98	0.000	115.8*	5.52		20.90	0.000
Salary	18.25*	1.86	0.243	9.943	0.000	19.87*	1.905	0.258	10.35	0.000
Race	19.26*	0.86	0.535	22.54	0.000	18.36*	0.889	0.500	20.69	0.000
Experience	5.010*	2.20	0.056	2.227	0.026	6.281*	2.335	0.068	2.690	0.007
Middle School										
(Constant)	108.1*	6.76		16.00	0.000	121.3*	6.530		18.58	0.000
Salary	24.26*	2.39	0.343	10.11	0.000	24.99*	2.316	0.390	10.79	0.000
Race	20.20*	1.13	0.595	17.87	0.000	15.96*	1.091	0.519	14.63	0.000
Experience	2.407*	3.12	0.027	0.770	0.442	0.538*	3.019	0.007	0.178	0.859

Note: *p < 0.05

However, the teachers' factors by themselves cannot explain very well the variability in student test scores (39% for Math and 36.7% for ELA, Table VI).

For middle schools, only salary and race factors are significant at 5% confidence level. Teacher experience is not significant (p = 0.859, Table IV). Furthermore, teacher factors fare better in explaining the variation in student test scores (53.8% for Math and 47.5% for ELA, Table VI).

The relationships between schools' individual factors (climate and FESR) and Math and ELA test scores for elementary schools are significant at 5% confidence level (p < 0.05, Table V).

School factors explain the variability in student test scores better than teachers' factors (52.2% for Math and 49.1% for ELA, Table VI). For middle schools, all school factors are significant at 5% confidence level and substantially explain the variability in student test scores (64.1% for Math and 60.5% for ELA, Table VI).

Table VII show that students' individual factors (attendance and mobility) do affect Math and ELA test scores for elementary and middle schools at 5% confidence level. Students' factors can moderately explain the variability in student test scores for both elementary (41.8% for Math and 41.3% for ELA, Table VI) and middle schools (51.8% for Math and 47.1% for ELA, Table VI).

TABLE V: RELATIONSHIP COEFFICIENTS BETWEEN SCHOOL FACTORS AND SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	117.2*	3.94		29.72	0.000	110.4*	4.15		26.62	0.000
Climate	13.32*	0.99	0.296	13.42	0.000	12.85*	1.04	0.280	12.30	0.000
FESR	24.17*	0.95	0.558	25.26	0.000	24.11*	1.00	0.546	23.96	0.000
Middle School										
(Constant)	89.28*	5.44		16.38	0.000	103.9*	5.18		20.05	0.000
Climate	14.18*	1.48	0.313	9.541	0.000	12.49*	1.41	0.304	8.83	0.000
FESR	24.75*	1.36	0.596	18.20	0.000	21.81*	1.29	0.579	16.86	0.000

Note: *p < 0.05

TABLE VII: RELATIONSHIP COEFFICIENTS BETWEEN STUDENT FACTORS AND SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	138.6*	3.69		37.55	0.000	128.9*	3.77		34.14	0.000
Mobility	25.49*	1.18	0.525	21.46	0.000	26.32*	1.21	0.531	21.65	0.000
Attendance	10.77*	1.15	0.228	9.335	0.000	10.22*	1.18	0.212	8.656	0.000
Middle School										
(Constant)	109.2*	5.58		19.55	0.000	121.6*	5.30		22.93	0.000
Mobility	34.82*	1.73	0.681	20.07	0.000	28.76*	1.64	0.620	17.45	0.000
Attendance	4.39*	1.30	0.114	3.356	0.001	5.96*	1.24	0.170	4.796	0.000

Note: *p < 0.05

TABLE VII: INDIVIDUAL AND COMBINED LINEAR REGRESSION MODELS: SUMMARY OF THE RELATIONSHIP BETWEEN TEACHER, SCHOOL AND STUDENT FACTORS AND SCALED MATH AND ELA SCORES

Regression Model	R	R Square	Adjusted R Square	Std. Err of the Estimate
Elementary Math Scores				
Teacher Factors	0.624	0.390	0.388	31.478
School Factors	0.722	0.522	0.521	27.863
Student Factors	0.647	0.418	0.417	30.716
Combined Factors	0.836	0.698	0.697	22.176
Elementary ELA Scores				
Teacher Factors	0.606	0.367	0.366	32.660
School Factors	0.700	0.491	0.490	29.307
Student Factors	0.643	0.413	0.412	31.436
Combined Factors	0.820	0.672	0.670	23.582
Middle Math Scores				
Teacher Factors	0.733	0.538	0.535	27.301
School Factors	0.801	0.641	0.639	24.139
Student Factors	0.720	0.518	0.516	27.905
Combined Factors	0.890	0.793	0.789	18.445
Middle ELA Scores				
Teacher Factors	0.689	0.475	0.471	26.368
School Factors	0.778	0.605	0.603	22.958
Student Factors	0.686	0.471	0.468	26.502
Combined Factors	0.861	0.742	0.738	18.663

TABLE VIII: RELATIONSHIP COEFFICIENTS BETWEEN STUDENT FACTORS AND SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	138.6*	3.69		37.55	0.000	128.9*	3.77		34.14	0.000
Mobility	25.49*	1.18	0.525	21.46	0.000	26.32*	1.21	0.531	21.65	0.000
Attendance	10.77*	1.15	0.228	9.335	0.000	10.22*	1.18	0.212	8.656	0.000
Middle Schhol										
(Constant)	109.2*	5.58		19.55	0.000	121.6*	5.30		22.93	0.000
Mobility	34.82*	1.73	0.681	20.07	0.000	28.76*	1.64	0.620	17.45	0.000
Attendance	4.39*	1.30	0.114	3.356	0.000	5.96*	1.24	0.170	4.796	0.000

Note: *p<0.5.

TABLE IX: RELATIONSHIP COEFFICIENTS BETWEEN TEACHER, SCHOOL AND STUDENT FACTORS AND SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS IN A COMNIBED LINEAR REGRESSION MODEL

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	60.26*	4.52		13.33	0.000	48.89*	4.80		10.17	0.000
Mobility	12.14*	0.97	0.250	12.47	0.000	13.51*	1.03	0.273	13.05	0.000
Climate	7.824*	0.84	0.174	9.315	0.000	7.543*	0.89	0.165	8.444	0.000
FESR	14.31*	0.87	0.330	16.43	0.000	14.29*	0.92	0.324	15.44	0.000
Salary	13.58*	1.30	0.181	10.40	0.000	15.07*	1.38	0.197	10.85	0.000
Race	6.977*	0.73	0.194	9.446	0.000	5.793*	0.78	0.158	7.376	0.000
Experience	-0.28*	1.60	-0.003	-0.17	0.860	0.733*	1.70	0.008	0.429	0.668
Attendance	8.226*	0.85	0.174	9.595	0.000	7.631*	0.91	0.159	8.370	0.000
Middle School										
(Constant)	48.37*	5.47		8.828	0.000	65.96*	5.54		11.89	0.000
Mobility	14.18*	1.48	0.276	9.567	0.000	11.23*	1.50	0.241	7.491	0.000
Climate	7.520*	1.21	0.166	6.180	0.000	6.750*	1.23	0.164	5.482	0.000
FESR	13.69*	1.24	0.330	11.03	0.000	13.15*	1.25	0.350	10.47	0.000
Salary	14.34*	1.69	0.202	8.487	0.000	15.32*	1.71	0.238	8.960	0.000
Race	7.190*	1.02	0.211	7.033	0.000	4.582*	1.03	0.148	4.429	0.000
Experience	0.708*	2.14	0.008	0.331	0.741	-0.59*	2.16	-0.007	-0.27	0.784
Attendance	2.602*	0.94	0.067	2.767	0.000	3.663*	0.95	0.104	3.850	0.000

Note: *p<0.5.

Table VIII shows that collectively there is a strong relationship between all independent variables (teacher, school, and student) and student test scores in Math and ELA. The only exceptions are for teacher experience in elementary (p = 0.860 for Math and p = 0.688 for ELA) and middle (p = 0.741 for Math and p = 0.784 for ELA) schools. The combined main effects of all independent variables can significantly explain the variation in student test scores for both elementary (69.8% for Math and 67.2% for ELA, Table VI) and middle schools (79.3% for Math and 74.2% for ELA, Table VI).

C. Multivariate Linear Regression – Model 2

Model 2 attempts to predict the interaction effects within teacher, school, and student factors on student test scores in Math and ELA. For elementary schools, all individual factors are significant at the 5% confidence level except for teacher experience (p = 0.926 for Math and p = 0.53 for ELA, Table IX). The interaction within student factors (attendance and mobility) is not significant for Math (p = 0.183, Table IX) but is significant for ELA (p < 0.05, Table IX). The interactions within school factors (climate and FESR) and within teacher factors (salary, race, and experience) are not significant for Math (p = 0.951, Table IX) and ELA (p = 0.649, Table IX). The interactions within independent variables (teacher, school, and student) do not add further explanation to the variability in the student Math test scores and are not significant (Tables IX and X). However, the interaction effects within student factors are significant for ELA test scores (p < 0.05, Table IX), but added a minimal explanation to the test score variability (Table X).

TABLE X: COEFFICIENTS OF INTERACTION EFFECTS WITHIN TEACHER, SCHOOL AND STUDENT FACTORS ON SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	59.59*	4.88		12.21	0.000	47.51*	5.16		9.204	0.000
Mobility	11.93*	0.98	0.245	12.09	0.000	12.91*	1.04	0.261	12.37	0.000
Climate	8.028*	0.88	0.179	9.088	0.000	7.942*	0.93	0.173	8.498	0.000
FESR	14.22*	0.87	0.328	16.25	0.000	14.00*	0.92	0.317	15.12	0.000
Salary	13.47*	1.33	0.179	10.08	0.000	14.99*	1.41	0.196	10.59	0.000
Race	7.142*	0.77	0.198	9.205	0.000	6.288*	0.82	0.171	7.661	0.000
Experience	-0.151*	1.63	-0.002	-0.093	0.926	1.083*	1.72	0.012	0.628	0.530
Attendance	8.146*	0.86	0.172	9.466	0.000	7.392*	0.91	0.154	8.119	0.000
Mobility* Attendance	1.164*	0.87	0.023	1.331	0.183	3.380*	0.92	0.065	3.655	0.000
Climate* FESR	0.096*	0.83	0.002	0.116	0.908	-0.336	0.87	-0.007	-0.383	0.702
Salary* Race* Experience	-0.139*	2.24	-0.001	-0.062	0.951	-1.084	2.37	-0.008	-0.456	0.649
Middle School										
(Constant)	43.22*	5.88		7.348	0.000	63.66	5.90*		10.77	0.000
Mobility	13.27*	1.50	0.259	8.795	0.000	9.943	1.51*	0.214	6.559	0.000
Climate	9.194*	1.28	0.203	7.158	0.000	8.145	1.29*	0.198	6.312	0.000
FESR	13.58*	1.22	0.327	11.08	0.000	12.86	1.23*	0.342	10.44	0.000
Salary	12.75*	1.72	0.180	7.418	0.000	13.50	1.72*	0.210	7.814	0.000
Race	7.536*	1.03	0.221	7.253	0.000	5.079	1.04*	0.165	4.866	0.000
Experience	1.785*	2.14	0.020	0.834	0.405	0.284	2.15*	0.004	0.132	0.895
Attendance	2.569*	0.93	0.066	2.762	0.006	3.799	0.93*	0.108	4.067	0.000
Mobility* Attendance	1.889*	0.99	0.043	1.898	0.058	3.477	1.00*	0.088	3.477	0.001
Climate* FESR	3.252*	1.01	0.078	3.215	0.001	2.382	1.01*	0.063	2.344	0.020
Salary* Race* Experience	1.670	2.50	0.015	0.668	0.505	3.681	2.51*	0.037	1.466	0.143

Note: *p<0.5.

For middle schools, all individual factors are significant at the 5% confidence level except for teacher experience (p = 0.405 for Math and p = 0.895 for ELA, Table IX). The interaction within student factors (attendance and mobility) is not significant for Math (p = 0.058, Table IX) but is significant for ELA (p = 0.001, Table IX). The interaction within school factors (climate and FESR) is significant for Math (p = 0.001, Table IX) and ELA (p = 0.020, Table IX), while the interactions within teacher factors (salary, race, and experience) are not significant for Math and ELA. The interactions within independent variables (teacher, school, and student) add a minimal explanation to the variability in Math and ELA test scores (Table X).

D. Multivariate Linear Regression - Model 3

Model 3 attempts to predict the interaction effects between the three independent variables (teacher, school, and student) on student test scores in Math and ELA. For elementary schools, all individual factors are significant at the 5% confidence level except for teacher experience (p = 0.881 for Math and p = 0.386 for ELA, Table XI). The interaction effects between teacher and student factors are not significant for Math (p = 0.581, Table XI) and ELA (p = 0.214, Table XI). The interaction effects between teacher and school factors are significant for Math (p = 0.020, Table XI) but not significant for ELA (p = 0.058, Table XI). The interaction effects between school and student factors are not significant for both Math (p = 0.322, Table XI) and ELA (p = 0.771, Table XI). The interactions between the three independent variables add a minimal explanation to the variability in the Math and ELA test scores.

TABLE XI: MAIN AND INTERACTION EFFECTS REGRESSION MODELS: SUMMARY OF THE RELATIONSHIP BETWEEN TEACHER, SCHOOL AND STUDENT FACTORS AND SCALED MATH AND ELA SCORES

Regression Model	R	R Square	Adjusted R Square	Std. Err of the Estimate	R Square Change	F Change	Sig. F Change
Elementary Math							
Main Effects	0.836	0.698	0.697	22.176	0.698	374.5*	0.000
Interactions Within	0.836	0.699	0.696	22.188	0.000	0.608*	0.610
Interactions Between	0.837	0.700	0.698	22.139	0.002	2.29	0.077
Elementary ELA							
Main Effects	0.820	0.672	0.670	23.582	0.672	330.7*	0.000
Interactions Within	0.822	0.676	0.673	23.473	0.004	4.51*	0.004
Interactions Between	0.821	0.674	0.671	23.543	0.002	2.26	0.079
Middle Math							
Main Effects	0.890	0.793	0.789	18.445	0.793	241.8*	0.000
Interactions Within	0.895	0.801	0.796	18.146	0.008	5.90*	0.001
Interactions Between	0.892	0.795	0.790	18.400	0.002	1.72	0.161
Middle ELA							
Main Effects	0.861	0.742	0.738	18.663	0.742	181.8*	0.000
Interactions Within	0.895	0.755	0.750	18.229	0.014	8.11*	0.000
Interactions Between	0.866	0.749	0.744	18.449	0.008	4.44*	0.004

Note: *p < 0.05

For middle schools, all individual factors are significant at the 5% confidence level except for teacher experience (p = 0.312 for Math and p = 0.745 for ELA, Table XI). The interaction between teacher and student factors is not significant for both Math (p = 0.596, Table XI) and ELA (p = 0.573, Table XI). The interaction between teacher and school factors is also not significant for both Math (p = 0.321, Table XI) and ELA (p = 0.073, Table XI). However, the interaction between school and student factors is significant for Math (p = 0.049, Table XI) and ELA (p = 0.02, Table XI). The interactions between the three independent variables add a minimal explanation to the variability in the student Math and ELA test scores

VII. DISCUSSION

To better understand the significant antecedents of student test scores in Math and ELA in public schools, a holistic approach that includes all probable factors and their interactions must be considered. While prior research focused on one or two factors at a time, this study includes three main independent variables and seven factors associated with them.

A. Teacher Factors

Results show that teacher salary has a statistically significant effect on Math and ELA test scores for elementary schools, while controlling other variables. A unit increase in teacher salary (i.e., $10k/year) can improve Math test scores by 18 points (8%) and ELA test scores by 20 points (9%). The impact is more significant for middle schools where a unit increase in teacher salary can improve Math test scores by 24 points (11%) and ELA test scores by 25 points (13%). One can argue that middle school teachers are more likely to be motivated to perform better and improve student test scores than elementary school teachers when they are compensated properly. The relationship between teacher wages and student outcomes has been debated amongst researchers and policymakers for decades. Proponents of a merit pay structure argue that such system has the potential to improve student test scores by motivating teachers to do better job in their classrooms or by competitively recruiting and retaining highly qualified teachers (Dee & Wyckoff, 2015). On the other hand, opponents of merit pay system cited other research where the impact of teacher wages on student test scores was negligent (Pham *et al*., 2020; Springer *et al*., 2014; (Fryer, 2013). The cited research claimed that the process of identifying efficacy in teaching is not reliable and cannot simply predict teacher quality, performance, or behavior based on a merit pay structure.

The relationship between teacher race and student test scores in Math and ELA is statistically significant, while controlling other variables. For elementary schools, a unit increase in teacher race (i.e., 25% increase in White teacher percentage) can improve Math test scores by 19 points (9%) and ELA test scores by 18 points (8%). For middle schools, a unit increase in teacher race can improve Math test scores by 20 points (9%) and ELA test scores by 16 points (8%). However, the causality of a better student performance with a higher percentage of White teachers cannot be merely derived from these results without looking at other factors.

In fact, a further review of the data from the state of Georgia tells us that minority teachers are more concentrated in Title I schools where school environment, resources, and student factors have negative impact on test scores. We know that minority teachers are not well represented in American public schools (Yarnel & Bohrnstedt, 2018; Partelow *et al*., 2017). Prior research has shown that the racial disparity in student test scores can improve by recruiting more minority teachers in schools (Savasci & Tomul, 2013). Student Math and Reading test scores has been shown to be positively impacted when students were matched with race-congruent teachers (Clotfelter *et al*., 2005; Partelow *et al*., 2017). These teachers can act integrators of diverse cultures, role models, and advocates for students with the same race or ethnicity.

TABLE XII: COEFFICIENTS OF INTERACTION EFFECTS BETWEEN TEACHER, SCHOOL AND STUDENT FACTORS ON SCALED MATH AND ELA SCORES FOR ELEMENTARY AND MIDDLE SCHOOLS

Variable	MATH					ELA				
	Unstandard Coeffes		Standard Coeffes	t	Sig.	Unstandard Coeffes		Standard Coeffes	t	Sig.
	B	Std. Err	Beta			B	Std. Err	Beta		
Elementary School										
(Constant)	57.64*	4.93		11.68	0.000	45.74*	5.22		8.762	0.000
Mobility	11.86*	0.98	0.244	12.03	0.000	12.86*	1.04	0.260	12.33	0.000
Climate	8.179*	0.88	0.182	9.251	0.000	8.072*	0.93	0.176	8.627	0.000
FESR	14.44*	0.87	0.333	16.42	0.000	14.15*	0.93	0.321	15.21	0.000
Salary	13.61*	1.33	0.181	10.17	0.000	15.13*	1.41	0.197	10.68	0.000
Race	7.012*	0.77	0.195	9.027	0.000	6.140*	0.82	0.167	7.468	0.000
Experience	0.245*	1.63	0.003	0.150	0.881	1.500	1.73	0.016	0.867	0.386
Attendance	8. 277*	0.87	0.175	9.510	0.000	7.512*	0.92	0.156	8.155	0.000
Teacher* Student	-1.72*	3.13	-0.011	-0.55	0.581	-4.11*	3.31	-0.026	-1.24	0.214
Teacher* School	-5.25*	2.25	-0.042	-2.33	0.020	-4.51	2.38	-0.035	-1.89	0.058
School* Student	0.890*	0.89	0.020	0.990	0.322	0.277	0.95	0.006	0.291	0.771
Middle School										
(Constant)	47.89*	5.68		8.427	0.000	65.77*	5.69		11.54	0.000
Mobility	14.06*	1.48	0.274	9.443	0.000	11.11*	1.49	0.239	7.445	0.000
Climate	7.746*	1.22	0.171	6.325	0.000	7.046*	1.22	0.171	5.738	0.000
FESR	13.59*	1.24	0.328	10.96	0.000	13.01*	1.24	0.346	10.46	0.000
Salary	13.75*	1.73	0.194	7.947	0.000	14.23*	1.73	0.221	8.206	0.000
Race	7.230*	1.03	0.212	6.956	0.000	4.580*	1.04	0.148	4.395	0.000
Experience	0.674	2.15	0.008	0.312	0.755	-0.70	2.16	-0.009	-0.32	0.745
Attendance	3.020*	0.95	0.078	3.158	0.002	4.329*	0.95	0.123	4.516	0.000
Teacher* Student	-0.99	1.88	-0.014	-0.53	0.596	-1.06	1.88	-0.016	-0.56	0.573
Teacher* School	0.225	0.22	0.026	0.994	0.321	0.408	0.22	0.053	1.798	0.073
School* Student	1.150	0.58	0.045	1.970	0.050	1.822	0.58	0.078	3.112	0.002

Note: *p < 0.05

Teacher experience has a statistically significant effect on Math and ELA test scores for elementary schools, while controlling other variables. However, a unit increase in teacher experience (i.e., nearly 15 years) can improve Math test scores by only 5 points (2%) and ELA test scores by 6 points (3%). The impact of teacher experience is not statistically significant for middle schools. These findings are consistent with the findings by Dial (2008), where the effect of teacher experience on overall student test scores in communication arts and Math sections of the Missouri Assessment Program (MAP) was investigated. Hanushek (1998) concluded that elementary school teachers with more years of experience had a modest positive effect on student test score (Dial, 2008). However, secondary school teachers with more years of experience had no or little effect on student test scores up to 20 years, when it then negatively affected test scores. Some researchers have argued that sometimes "more is not necessarily better" where the impact of more experienced teachers on student test scores starts to fade away after 5 years (Weaver, 2019; Ladd, 2008; Clotfelter, *et al*., 2007). Other researchers stated that early-career teachers up to 3 years of experience are more likely to teach in Title I schools where teacher quality and productivity is a challenge (Gershenson, 2016). Therefore, a deep dive into the distribution pattern of inexperience teachers is needed in order to fully understand the impact of teacher experience on student test scores.

B. School Factors

The climate star rate has a statistically significant effect on Math and ELA test scores, while controlling other variables. For elementary schools, a unit increase in climate star rate can improve Math test scores by 13 points (6%) and ELA test scores by 13 points (6%). The impact is similar for middle schools where a unit increase in climate star rate can improve Math test scores by 14 points (7%) and ELA test scores by 12 points (6%). The FESR rate is significantly more impactful than the climate star rate on the Math and ELA test scores. For elementary schools, a unit increase in FESR rate can improve Math test scores by 24 points (11%) and ELA test scores by 24 points (11%). The impact is similar for middle schools where a unit increase in FESR rate can improve Math test scores by 25 points (12%) and ELA test scores by 22 points (12%). School climate factor is multifaceted since it includes quantitively measured attributes such as student record, teacher record, safe environment, substance free, as well as perceived attributes such as teacher and parent surveys. According to some researchers it is one of the leading contributors in explaining student learning and test scores (Maxwell, *et al*., 2017; Dulay & Karadağ, 2017; Maxwell, 2016) as well as student emotional and behavioral achievements (Newland, *et al*., 2019). Furthermore, there is overwhelming evidence in research that per pupil expenditure (PPE) is positively correlated to student learning and standardized test scores (Jackson *et al*., 2016; Sun, 2014; Hanushek & Woessmann, 2017; Ostrander, 2015). Increase

in PPE is especially critical for low-income children and Title 1 schools since research has shown such an increase will reduce achievement gaps between low-income students and their peers and yield higher graduation rate, higher earnings, and reduction in adult poverty (Cooper, 2017; Jackson *et al*., 2016).

C. Student Factors

The mobility rate has a high positive correlation with the Math and ELA test scores, while controlling other variables. For elementary schools, a unit increase in the mobility rate scale (less mobile) can improve Math test scores by 25 points (11%) and ELA test scores by 26 points (12%). The impact was higher for middle schools where a unit increase in the mobility rate scale can improve Math test scores by 34 points (16%) and ELA test scores by 29 points (15%). This finding suggests that middle school students may have harder time to cope with a new school than elementary school students. The content areas in middle school are more structured and academically challenging than elementary school subjects. Hence, adjustment period to a new school environment can be longer for middle school students. In addition, a change in a school can create significant social challenges for middle school students such as leaving old friends behind and trying to create new ones. This finding is consistent with the general consensus in literature that more mobility is associated with negative outcomes on academic achievement (Sparks, 2016-(Rhodes, 2005). Other researchers have argued that mobility by itself is not the main effect for an unsatisfactory student's outcome but rather a combination of other factors. For example, highly mobile students tend to come from low-income families where parents did not attain higher education and did not have stable jobs (Donnelly & Gamsu, 2018; Welsh, 2017).

The attendance rate was less impactful than the mobility star rate on the Math and ELA test scores. For elementary schools, a unit increase in attendance rate can improve Math test scores by 11 points (5%) and ELA test scores by 10 points (5%), while controlling other variables. The impact is much less for middle schools where a unit increase in attendance rate can improve Math test scores by only 4 points (2%) and ELA test scores by 6 points (3%). There is overwhelming evidence in the literature pointing to a positive impact of attendance rate on student test scores (McGahee, 2019; Gottfried, 2010). The NCLB Act of 2001 dictates states, school districts, and individual schools to report student attendance as part of the Adequate Yearly Progress (AYP) requirements; hence emphasizing its impact on student and school performance (No Child Left Behind Act of 2001, 2002).

D. Combined Effect of Teacher, School, and Student Factors

The aggregate main effect of teacher, school, and student factors shows statistically significant relationships between all factors and student test scores in Math and ELA, except for teacher experience (Table VIII). The influence of each factor on student test scores in this combined linear regression model was less pronounced than in the individual linear regression models for each independent variable. For example, a unit increase in FESR rate yielded an increase of 11% in Math test score for elementary school students when school factors were analyzed separately. However, a unit increase in FESR rate in the combined regression model can yield an increase of only 6% in Math test scores (Tables V and VIII). This finding posits the use of a systemic approach when analyzing standardized student test scores. Eliminating any of the contributing factors during exploratory research on this topic can produce erroneous or inadequate conclusions and generate education policies based on fragmented evidence.

E. Interaction Effects Within and Between Teacher, School, and Student Factors

Table IX shows the interaction effects within independent variables for elementary and middle schools. There is no statistically significant interaction within factors for elementary schools on the Math test scores. The only statistically significant interaction effect within factors for ELA test scores is for student variable (mobility*Attendance, $p < 0.05$). However, the impact of this interaction is almost negligible. For example, for every unit change in mobility rate, the slope change of the attendance rate on the ELA test score will increase by only 3.38. For middle schools, there is a statistically significant interaction effect within school factors (climate*FESR, $p = 0.001$) for Math test scores and within student factors (mobility*Attendance, $p = 0.001$) and school factors (climate*FESR, $p = 0.020$) for ELA test scores. The impact of all statistically significant interactions within factors on student test scores is inconsequential. This is supported by the lack of additional explanation in variability in test scores after adding the interaction effects within factors to the combined regression model. In order to address improvements in student test scores, this finding suggests that researchers should focus on individual contribution of factors in a combined model structure rather than the interaction within various factors.

Table XI shows the interaction effects between independent variables for elementary and middle schools. There is no statistically significant interaction between variables for elementary schools on the ELA test scores. The only statistically significant interaction effect between variables for Math test scores is between teacher and school factors (teacher*school, $p = 0.020$). The impact of this interaction is modest. For example, for every unit change in teacher variable, the slope change of the school variable on the Math test score will decrease by 5.25. For middle schools, there is no statistically significant interaction effect between variables for Math test scores but there is one statistically significant interaction effect between school and student factors for ELA test scores. However, this statistically significant interaction has a very low impact on the ELA test scores. These results were supported by the lack of additional explanation in variability in test scores after adding the interaction effects between variables (Table X).

VIII. Conclusion

The statistical results from this study attempt to address the multifaceted antecedents that influence standardized Math and ELA tests in elementary and middle public schools in the state of Georgia. It provides a holistic view to the growing body of research that addresses school accountability as

demanded by the national and state legislations. The use of standardize tests has dramatically increased after the NCLB act in 2001 and such tests are being used by large number of states as part of school assessment and to drive a better student learning and achievement (National Assessment of Educational Progress, n.d.; Cirino *et al*., 2018; Vanlaar *et a*l., 2015). Although researchers have studied the individual influence of certain teacher, school, or student factors on student test scores, a void in research to examine the combined effects of factors and the interactions within and between them still exists.

As expected, the individual effect of each factor correlates positively with student test scores when each independent variable is analyzed separately. However, the influence of each factor on student test scores drops dramatically when all three independent variables are included in the regression model. In fact, the effect of teacher experience is found to be not statistically significant in a combined linear regression model. Educators and policymakers should use caution when deriving educational policies based on research findings from studies that explored a single or only a few contributing factors. The second multivariate linear regression model reveals that the interactions within factors are not impactful on student test scores. Adding more factors such as student socio-economic status, cultural background, English language proficiency, and teacher certification level might alter this finding. The third multivariate linear regression model reveals that the interactions between the three independent variables have modest impact on student test scores. Adding more factors for each independent variable has the potential of yielding a different result.

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