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School Culture and Climate for Younger Learners: Measurement and Association with Academic Achievement

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SCHOOL CULTURE AND CLIMATE FOR YOUNGER LEARNERS: MEASUREMENT AND ASSOCIATION WITH ACADEMIC ACHIEVEMENT

by

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ABSTRACT

SCHOOL CULTURE AND CLIMATE FOR YOUNGER LEARNERS: MEASUREMENT AND ASSOCIATION WITH ACADEMIC ACHIEVEMENT

by

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This study seeks to understand the measurement of younger students' perceptions of the school learning environment and their possible association with academic achievement. The target population is 4th and 5th grade students. Their perception of the school environment was compared to 7th graders by factor analysis, measurement invariance, differential item functioning, and hierarchical linear modeling. This study found that younger students' perceptions are different from middle school students. However, like their middle school peers, these perceptions still predict academic performance.

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School Culture and Climate for Younger Learners: Measurement and Association with Academic Achievement

Leon J. Gilman, University of Wisconsin-Milwaukee

Introduction

Both the physical and social aspects of schools play important roles in students' lives. Positive learning environments allow students to actively engage with teachers and academic materials. For educators and school leaders, these environments cultivate trusting relationships. A positive social dynamic within a school also leads to positive learning outcomes (Bryk, Sebring, Allensworth, Easton, & Luppescu, 2010).

Students' perceptions of the learning environment are important. Aspects of this learning environment, such as trust, are critical elements of pedagogy and are associated with school improvement. Although researchers seldom survey young students' perceptions, children actually possess basic ideas of teaching. For example, children as young as three years of age are already able to distinguish between teaching and imitation, assess the reliability of an informant, and understand whether teaching will take place (Koenig & Harris, 2005a, 2005b; Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008). Thus, it is worthwhile to systematically study the perception of young children of schools, as this may reveal how they form and handle their relationships with peers, teachers, and other aspects of school life.

On the other hand, measuring the perceptions of school environments for younger children can be challenging. Their perceptions may vary by gender, ethnicity, or even grade. So far, little attention has been paid toward these younger learners. Most studies on school environments have focused on middle or high school students. Even when younger students are the target population, researchers usually borrow the measures developed for older students. Due to the unique developmental stages of younger students, the validity of these measures can be questioned.

Meanwhile, efforts on testing the validity of school culture and climate instruments have mainly focused on the overall structure of the construct. Little attention has been paid to the possible differences between groups of students. These potential differences may show how groups value specific aspects of their school's learning environment, which can help schools improve. Another way this group difference may show is their association with academic achievement. While it is generally believed that positive perceptions of a school's culture and climate are associated with higher achievement, how that association manifests with younger learners is unclear.

This study aims to bridge the above gaps by studying the perceptions of school culture and climate for younger students. The focus is on students' perceptions, one very important aspect of a school's culture and climate. Collectively the perceptions measure the learning environment of the school from students' perspectives. The first goal of this study is on how to measure younger students' perceptions of the school learning environment. This will be achieved by analyzing younger learners' responses to a popular school culture and climate survey. Potential differences between younger learners and their middle school peers will then be explored at both the survey and question levels. The second objective of this study is to explore how younger student perceptions may be associated with math and reading achievement.

Literature Review

School Culture and Climate

The origins of studying a school's culture and climate can be traced back to organizational climate research and studies on successful corporate culture (Hoy & Miskel, 2013; Zullig, Koopman, Patton, & Ubbes, 2010). Initial research focused on how to promote positive outcomes among employees by improving the organizational structure of companies. This general framework was extended and applied to schools in the late 1970s with more empirical research being published in the 1980s and 1990s (Zullig et al., 2010).

Both school culture and climate describe the dynamics of social life within a school (Bryk et al., 2010), but they are not the same. School climate is made of dominant patterns of behavior, hence it is the general feeling or atmosphere in a school (Hoy & Miskel, 2013). School culture, on the other hand, has a symbolic significance and is a shared set of core beliefs, norms, values, or history (Hoy & Miskel, 2013). Together, school culture and climate define a school's character, the sense of school life, or the school's academic optimism (Bryk et al., 2010; Cohen, Mccabe, Michelli, & Pickeral, 2009; Hoy, Tarter, & Hoy, 2006).

A clear association has been established between school culture and climate and the life of students. As stated by Cohen et al. (2009), "a sustainable, positive school climate fosters youth development and learning necessary for a productive, contributive, and satisfying life in a democratic society" (p. 182). A variety of theories, such as Bio-Ecological Theory (Bronfenbrenner, 1979), also show how a positive school culture and climate can affect the lives of students (Wang & Degol, 2016).

Measurement of School Culture and Climate

The exact definition of school culture and climate is still under discussion (Anderson, 1982; Cohen et al., 2009; Thapa, Cohen, Guffey, & Higgins-D'Alessandro, 2013; Wang & Degol, 2016; Zullig et al., 2010). However, there is little doubt that core indicators, such as safety or trust, measure school culture and climate. Moreover, school culture and climate is deemed as multidimensional and multi-level with variability at the student-, classroom-, and school-level.

Numerous instruments are available for measuring school culture and climate. Yet, their validity vary (Ramelow, Currie, & Felder-Puig, 2015; Zullig et al., 2015). One interesting aspect of validity is measurement invariance, which aims to examine the perceptual differences among groups, such as between teachers and administrators, between students of different gender or race, between middle and high school students, and among high school students in different grades.(Bear, Yang, Pell, & Gaskins, 2014; Bradshaw, Waasdorp, Debnam, & Johnson, 2014; Johnson, Stevens, & Zvoch, 2007; E. Lee et al., 2017; Phillips & Rowley, 2016; Zullig et al., 2015). However, few studies have explored the measurement invariance of school culture and climate over elementary, middle and high school grades (Bear, Gaskins, Blank, & Chen, 2011).

Student Outcomes

A positive school culture and climate is associated with positive student outcomes. It fosters a supportive learning environment where students can be actively engaged, be challenged, while having strong support and feelings of safety. A positive school culture and climate also deters students from maladaptive behaviors and promotes more prosocial behaviors. For example, a positive school culture and climate is associated with higher amount of general student safety (DeRosier & Newcity, 2005), less school violence (Benbenishty, Astor, Roziner,

& Wrabel, 2016), less student victimization or bullying (Cornell, Shukla, & Konold, 2015; Gregory et al., 2010), and fewer risk behaviors (Cornell & Huang, 2016; Klein, Cornell, & Konold, 2012). In addition, a positive school culture and climate is associated with positive psychological or social outcomes (Jia et al., 2009), higher responsibility among students (Syvertsen, Flanagan, & Stout, 2009), and greater student engagement with their school (Brady, 2005).

A positive school culture and climate is associated with higher academic achievement in elementary, middle, and high schools (Bear et al., 2011; Brookover et al., 1978; Davis & Warner, 2015; Esposito, 1999; V. E. Lee & Smith, 1999; Lynch, Lerner, & Leventhal, 2013; Sherblom, Marshall, & Sherblom, 2006). One positive agent for this association is the academic press by schools. Schools with higher academic press on their students are associated with positive student outcomes (Goddard, Sweetland, & Hoy, 2000; V. E. Lee & Smith, 1999) since students are pushed to perform at their highest ability with instructional support. This association is still present even after controlling for socioeconomic standing (Hoy, 2012). Another possible reason for this connection to student achievement is trust. Higher levels of trust within students, educators, or school leaders are also associated with student achievement and school improvement (Adams & Forsyth, 2013; Bryk & Schneider, 2002). Thus, trust facilitates the initiation, continuation, and magnitude of school improvement efforts (Bryk et al., 2010) since it enables individuals within a school to work together cooperatively (Hoy & Miskel, 2013).

Research Questions

This study aims to answer the following two research questions:

1. Does the perception of school culture and climate differ between younger and older learners?
2. How does this perception of younger learners relate to academic achievement?

Methods

Sample

The sample came from a large Midwestern urban school district. Secondary analysis was conducted on 4th, 5th, and 7th grade students survey responses from every school in the district during the 2015-2016 school year. The original sample contained a total of 10,399 student responses, 2,882 7th grade students, and 7,517 4th and 5th grade students. Young learners made up roughly 70% of this original sample. Based on a fall 2015 record of students, 70.01% of all 4th and 5th grade and 60.2% of 7th grade students responded to the survey. Three students had missing responses to all survey questions, thus excluded from the analysis. This led to the final sample of 10,396 students.

Instrument

Data was collected by the 5Essentials of School Culture and Climate (5Essentials) survey. This survey was designed by Chicago Public Schools and the Consortium on Chicago School Research. The aim of this survey is to assess the organizational factors that are associated with school improvement. Using longitudinal data, Bryk and his colleagues (2010) showed how five organizational subsystems interact to enhance or undermine the overall dynamics of student learning. These subsystems are a supportive environment, ambitious instruction, involved families, collaborative teachers, and effective leaders. Gains in some or all of these subsystems influence student outcomes through students increased motivation and engagement in classroom instruction. Their study looked at the internal and external conditions necessary for school improvement from principals, teachers, and 6th and 8th grade students in elementary schools.

The 5Essentials uses a student and staff version to assess these five subsystems. The student survey has 43 questions, which are listed in Table 10 in the Appendix. These questions measure two constructs: supportive environment and ambitious instruction. The supportive environment construct is characterized as how safe students feel, what the academic expectations are, and how supportive students feel their teachers and peers are. Ambitious instruction is how students perceive the organization of the curriculum and the academic demands placed on them. The 28-item supportive environment construct consists of five subscales: safety, student-teacher trust, academic personalism, academic press, and peer support for academic work. The 15-question ambitious instruction scale consists of three subscales: English instruction, math instruction, and course clarity.

Not all survey questions were asked to 4^{th}, 5^{th}, and 7^{th} graders in this sample. The academic press subscale questions were not asked to 7^{th} grade students. Although not included in the analysis, these questions are important components of a school's culture and climate. Students' perceptions of academic rigor affect student achievement and are associated with short and long term school success (Smith & Kearney, 2013). For this research, a focus on the common domains and items asked to 4^{th}, 5^{th}, and 7^{th} grade students were taken with the academic press subscale removed.

This study used the STAR Reading and Math exam to assess academic achievement for younger learners. Both of these exams are computerized adaptive formative assessments that measure student progress and to identify deficits in student learning. The reading exam consists of 46 reading skills which make up 11 domains. The math exam is composed of 11 domains for 1st through 8th graders. Both STAR Reading and STAR math have shown acceptable reliability and validity (Plake, Impara, & Spies, 2003; Spies & Plake, 2005).

Variables

Student-level variables included student responses to the 5Essentials survey, 4th and 5th grade gender, ethnicity, economic disadvantaged status, and a constructed score representing student perceptions of the learning environment. Economic disadvantage was measured by student's participation on the free or reduced lunch program. Like in previous school culture and climate research, these demographic variables were used as control variables in the HLM analysis.

A 5Essentials score was constructed by using a bifactor graded response model (Gibbons et al., 2007). This model had one general factor and seven specific factors. The seven specific factors correspond to seven common subscales between 4th, 5th, and 7th grade students. The general factor score, which reflects shared interest in the perception of school culture and climate by the seven subscales, was used as an independent variable in the HLM analysis and the controlling variable in the DIF analysis.

School-level variables included school type, percentage of students of color, percentage of students that are economically disadvantaged, and average 5Essentials school score aggregated from student 5Essentials scores. School type was divided into two types: Elementary (K to 5th grade) and mixed school (K to beyond 5th grade). The second type included three schools up to 12th grade and three schools up to 6th, 7th and 9th grade. Economic disadvantage status was the percentage of students receiving free or reduced lunch. A school 5Essentials score was simply the mean of the student 5Essentials score.

The dependent variables for the HLM analysis were the reading and math scaled scores from the STAR Exam. One advantage of using the scaled scores lies in their comparability across grades, as they are placed on a vertical grade scale (Tan & Michel, 2011).

Analyses

Four analyses were run, each targeting a specific research question. First, confirmatory factor analysis (CFA) examined competing measurement models about school culture and climate construct for younger students. These models were similar to those in previous research (Bear et al., 2011; Yang et al., 2013). As illustrated in Figure 1, five models studied were one-factor, two-factor, seven-factor, bifactor, and higher-order.

The second analysis tested the measurement invariance between younger and older students. This analysis explored potential systematic differences between younger (4^{th} and 5^{th} grade) and older (7^{th} grade) students' perceptions. Since perceptual views between middle and high school students have been shown consistent (E. Lee et al., 2017; Phillips & Rowley, 2016), this analysis sought to understand whether younger students view the school learning environment differently. The measurement invariance analysis was based on the factor structure established in the factor analysis step.

The third analysis used differential item functioning (DIF) to assess the performance of survey items. This evaluated how the survey may have performed differently for different grades at the item-level. The focal and reference groups are the 4^{th} and 5^{th} grade, and 7^{th}, respectively. In the case that measurement invariance does not hold, this DIF analysis will be able to reveal where the invariance may have been violated.

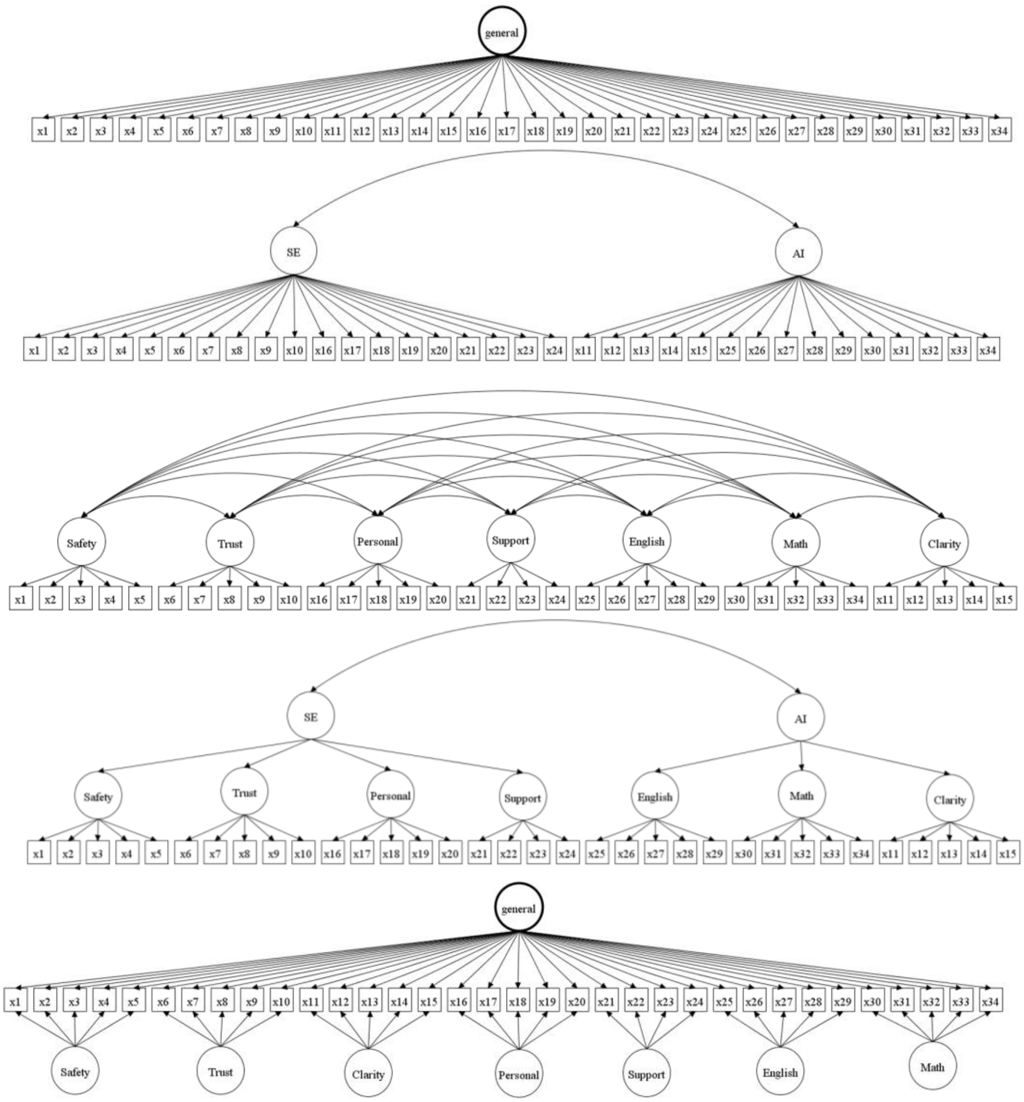

Figure 1[1]**:** Five factor structures of students' perceptions of the learning environment

Lastly, how the perception of school culture and climate may be related to the academic achievement was studied by multi-level modeling. Common student- and school-level variables were controlled in the HLM analysis. Reading and math scores from the STAR exam were used to measure academic achievement.

[1] Note: general = General factor, SE = Supportive Environment, AI = Ambitious Instruction, Safety = Safety subscale, Trust = Student-Teacher Trust subscale, Personal = Academic Personalism subscale, Support = Peer Support for Academic Work subscale, English = English Instruction subscale, Math = Math Instruction subscale, Clarity = Course Clarity subscale

Procedures

To test model data fit, Chi-square fit statistics (χ^2), root mean square error of approximation (RMSEA) and comparative fit index (CFI) were used. The following criteria were adopted: a non-significant chi-square fit test, a RMSEA at or lower than 0.08, and a CFI at or above 0.90 (Chen, 2007; Hu & Bentler, 1999; Vandenberg & Lance, 2000).

In testing measurement invariance, three sequential models were compared. First, configural invariance compared two models (Model 1) with the same factor structure. All parameters were allowed to be free but the structure was fixed. Next, metric invariance (Model 2) tested if the factor loadings between the two groups were equivalent. This tested whether the meaning of the construct is the same across the two groups. Finally, scalar invariance (Model 3) tested if the thresholds are invariant or if the starting value of the construct is equivalent. The criteria used to determine measurement invariance was the chi-square test of likelihood difference.

The DIF analyses were based on ordinal logistic regression. The controlling variable was the general factor score derived from the model established in the factor analysis step. The grouping variable was the grade level using the 7^{th} grade as the reference group. To accommodate the multiple tests conducted in this analysis, the alpha level was set at 0.01.

CFA was conducted using the default settings in Mplus (Muthén & Muthén, 1998), which aims to use all available data through pairwise deletion and full information maximum likelihood estimation. In addition, the WLSMV estimator was used in all analyses and the DIFFTEST option was used for the chi-square test of likelihood difference. Student 5Essentials scores were computed through IRTPRO (Cai, Thissen, & du Toit, 2011). The standard setting in IRTPRO was used and maximum a posterior (MAP) scores were requested for theta estimates.

The multi-level model estimates were made through HLM7 (Raudenbush, Bryk, Cheong, Congdon, & Du Toit, 2011). The method of estimation used was restricted maximum likelihood and robust standard errors were used during interpretation.

DIF Model Specification

Two models were used to detect DIF in all survey items. The outcome variable for DIF analysis was the Likert-type scale response category for each question in the student survey. It is represented as the logit of two probabilities of endorsing category Y, which is expressed as,

$$\ln\left(\theta_j\right) = \frac{p(Y \leq j)}{p(Y > j)} \quad (1)$$

where j goes from 1 to j-1 and p is the proportion of respondents selecting category Y.

Model 1

The first model used only 5Essentials student score as a predictor defined as,

$$\ln\left(\theta_j\right) = \beta_{0j} + \beta_1(5Essentials) \quad (2)$$

where β_{0j} is the intercept for the j^{th} category and β_1(5Essentials) is the regression coefficient for the 5Essentials student score variable.

Model 2

The second model added the group and the 5Essentials student score by group interaction predictors,

$$\ln\left(\theta_j\right) = \beta_{0j} + \beta_1(5Essentials) + \beta_2(Group) + \beta_3(5Essentials \times Group) \quad (3)$$

were β_2(Group) is the regression coefficient for the grouping variable, and β_3(5Essentials×Group) is the 5Essentials student score by group interaction variable. β_2(Group) was used to test for uniform DIF, or whether an item consistently favors one group. β_3(5Essentials×Group) tested for non-uniform DIF which shows an item favors a different group across the ability continuum. Model 2 was compared to Model 1 to simultaneously test uniform and non-uniform DIF.

HLM Model Specification

Three HLM models were used to explore how students' perceptions impact student reading and math achievement.

Model 1

First, a null model examined how much variability in reading and math achievement can be attributed to the school-level. The two-level model is written as,

$$\text{Level 1: } Y_{ij} = \beta_{0j} + R_{ij}$$
$$\text{Level 2: } \beta_{0j} = \gamma_{00} + U_{0j} \tag{4}$$

where Y_{ij} is the i^{th} student's STAR reading or math score in the j^{th} school, R_{ij} is the level one residual effect for the i^{th} student, γ_{00} is the average intercept or the grand mean of all schools, and U_{0j} is the random effect for the j^{th} school.

An intra-class correlation (ICC) was computed to determine the percentage of the variance from the school-level. The ICC is,

$$\rho_I = \frac{\tau^2}{\tau^2 + \sigma^2} \tag{5}$$

where τ^2 represents the variation between schools and σ^2 is the variance within schools.

Model 2

A second model tested if the student-level 5Essentials score is a significant predictor by treating it as a fixed effect. The level one and level two models is,

$$\text{Level 1: } Y_{ij} = \beta_0 + \beta_1(Gender) + \beta_2(ED) + \beta_3(SoC) + \beta_4(5Essentials) + R_{ij}$$

$$\text{Level 2: } \beta_0 = \gamma_{00} + \gamma_{01}(SchType) + \gamma_{02}(SchSoC) + \gamma_{03}(SchED) + \gamma_{04}(Sch5Essentials) + U_{0j}$$

$$\beta_1 = \gamma_{10}$$

$$\beta_2 = \gamma_{20}$$

$$\beta_3 = \gamma_{30}$$

$$\beta_4 = \gamma_{40} \quad (6)$$

where β_1(Gender), β_2(ED), β_3(SoC), and β_4(5Essentials) were the coefficients for student gender, student economic disadvantage status, student of color, and 5Essentials score variables for the i^{th} student in the j^{th} school. In addition, γ_{01}(SchType), γ_{02}(SchSoC), γ_{03}(SchED) and γ_{04}(Sch5Essentials) all represent the average slope associated across schools for each school-level variable.

Model 3

The last model, Model 3, treated the 5Essentials student score as a random effect. It will only be used if there is a significant fixed effect of student 5Essentials scores. This random effect model further tested if this already significant relationship is dependent on school-level characteristics. This two-level model is written as,

Level 1: $Y_{ij} = \beta_0 + \beta_1(Gender) + \beta_2(ED) + \beta_3(SoC) + \beta_4(5Essentials) + R_{ij}$

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}(SchType) + \gamma_{02}(SchSoC) + \gamma_{03}(SchED) + \gamma_{04}(Sch5Essentials) + U_{0j}$

$$\beta_1 = \gamma_{10}$$

$$\beta_2 = \gamma_{20}$$

$$\beta_3 = \gamma_{30}$$

$$\beta_4 = \gamma_{40} + \gamma_{01}(SchType) + \gamma_{02}(SchSoC) + \gamma_{03}(SchED) + \gamma_{04}(5Essentials) + U_{4j} \quad (7)$$

substituting the level two model into the level one model gives the mixed model,

$$Y_{ij} = \gamma_{00} + \beta_1(Gender) + \beta_2(ED) + \beta_3(SoC) + \beta_4(5Essentials) + \gamma_{01}(SchType) + \gamma_{02}(SchSoC) + \gamma_{03}(SchED) + \gamma_{04}(Sch5Essentials) + \gamma_{41}(5Essentials \times SchType) + \gamma_{42}(5Essentials \times SchED) + \gamma_{43}(5Essentials \times \text{SchED}) + \gamma_{44}(5Essentials \times Sch5Essentials) + U_{0j} + U_{4j}(5Essentials) + R_{ij} \quad (8)$$

where γ_{41}(5Essentials×SchType), γ_{42}(5Essentials×SchED), γ_{43}(5Essentials×SchED), and γ_{44}(5Essentials×Sch5Essentials) are the cross-level interactions that represented the association each school-level variable had with the student 5Essentials score and achievement. In addition, U_{4j}(5Essentials) represents the random effect for the j^{th} school on the student-level slope adjusted for the school-level variables.

Results

Factor Structure and Measurement Invariance

Table 1 presents the model fit results. Both the one-factor and two-factor model showed poor fit. For the single factor model, χ^2 = 84,061.03 df = 527, $p < 0.001$, RMSEA = 0.12, CFI = 0.67; For the two-factor model: χ^2 = 68,750.92, df = 526, $p < 0.001$, RMSEA = 0.11, CFI = 0.73. This result indicated that students' perceptions of the learning environment does not have a one- or two-factor structure.

Table 1: Goodness-of-fit statistics for five models of students' perceptions of the learning environment

	χ^2	df	RMSEA	CFI
One-Factor Model	84,061.03	527	0.12	0.67
Two-Factor Model	68,750.92	526	0.11	0.73
Higher-Order Model	18,424.94	519	0.06	0.93
Seven-Factor Model	6,490.10	506	0.03	0.98
Bifactor Model	14,401.67	489	0.05	0.94

Note: χ^2 = chi-square, df = degrees of freedom, RMSEA = root mean square error of approximation, CFI = comparative fit index

Both the higher order and seven-factor model seemed to fit. For the higher order, χ^2 = 18,424.94, df = 519, $p < 0.001$, RMSEA = 0.06, CFI = 0.93; For the seven-factor model: χ^2 =

6,490.10, df = 506, $p < 0.001$, RMSEA = 0.03, CFI = 0.98. The RMSEA and CFI were below the values for a good fitting model. The bifactor model also showed acceptable fit, χ^2 = 14,401.67, df = 489 $p < 0.001$, RMSEA = 0.05, CFI = 0.94. All significant chi-square test results are probably due to the large sample size. Given that the bifactor model fit, is more parsimonious, and is able to generate one overall score that is required for the DIF and HLM analysis, it was chosen in the subsequent analysis.

The measurement invariance results of the bifactor model can be seen in Table 2. The baseline configural model fit with χ^2 = 16,866.13, df = 986, $p < 0.001$, CFI = .93 and RMSEA = .06. The difference between the metric and configural model was significant with χ^2 = 228.40, df = 60, $p < 0.001$. The difference between scalar and metric model was also significant with χ^2 = 5,683.16, df = 120, $p < 0.001$. These results indicated configural invariance was supported but metric and scalar invariance were violated.

Table 2: Bifactor model measurement invariance results

	χ^2	df	RMSEA	CFI
Configural	16,866.13	986	0.06	0.93
Metric vs. Configural	228.40	60	-	-
Metric vs. Scalar	5,683.16	120	-	-

Note: χ^2 = chi-square, RMSEA = root mean square error of approximation, CFI = comparative fit index

Differential Item Functioning

Table 3 presents the DIF testing results while Table 4 shows which items favored the focal or reference group. Of all 34 items, 22 items (64.7%) showed DIF. Of the 19 items in the supportive environment construct, 14 (73.7%) showed DIF. On the safety subscale, three items (60%) had DIF. These questions asked how safe students feel in the bathrooms, their class, and outside or around school. Only one item in the student-teacher trust subscale did not exhibit DIF. This question asked how safe and comfortable students feel with their teachers at school. On the academic personalism subscale, three items (60%) showed DIF. These questions asked students if their teacher is willing to give extra help on school work if they needed it, if their teacher gives specific suggestions about how they can improve their work, and if their teachers explain things in a different way if they do not understand something in class. The last subscale, peer support for academic work, had all four items showing DIF.

Table 3: Model Comparison for Differential Item Functioning (DIF) analysis

Item label	N*	-2LL Difference (df = 2)	p value	DIF Result
Safety1	10,132	0.44	0.803	No DIF
Safety2	9,971	61.58	<0.001	DIF
Safety3	9,976	51.18	<0.001	DIF
Safety4	9,926	2.68	0.262	No DIF
Safety5	10,074	24.02	<0.001	DIF
Trust1	10,111	46.46	<0.001	DIF
Trust2	9,992	8.86	0.012	No DIF
Trust3	9,946	91.51	<0.001	DIF
Trust4	9,922	34.74	<0.001	DIF
Trust5	9,972	28.92	<0.001	DIF
Personalism1	9,795	5.77	0.056	No DIF
Personalism2	9,663	14.28	0.001	DIF
Personalism3	9,677	5.34	0.069	No DIF
Personalism4	9,676	25.68	<0.001	DIF
Personalism5	9,648	50.42	<0.001	DIF
Support1	9,629	75.53	<0.001	DIF
Support2	9,506	122.15	<0.001	DIF
Support3	9,475	191.64	<0.001	DIF
Support4	9,464	229.64	<0.001	DIF
Clarity1	9,674	4.27	0.118	No DIF
Clarity2	9,590	1.62	0.444	No DIF
Clarity3	9,582	2.02	0.364	No DIF
Clarity4	9,581	10.53	0.005	DIF
Clarity5	9,562	2.58	0.276	No DIF
English1	9,693	8.08	0.018	No DIF
English2	9,537	39.18	<0.001	DIF
English3	9,540	16.21	<0.001	DIF
English4	9,575	2.37	0.306	No DIF
English5	9,542	13.60	0.001	DIF
Math1	9,412	42.72	<0.001	DIF
Math2	9,264	43.99	<0.001	DIF
Math3	9,290	78.30	<0.001	DIF
Math4	9,276	38.71	<0.001	DIF
Math5	9,257	0.07	0.964	No DIF

Note: N = Item sample size; -2LL = -2Loglikelihood; df = degrees of freedom.
*The total sample size was 10,396. Any item could have a lower sample size due to students missing a response to that question.

Eight (53.3%) of the 15 items in the ambitious instruction construct had DIF. Unlike the other subscales in the survey, the course clarity subscale only had one item (20%) with DIF. This question asks if students know what teachers want them to learn in class. Three questions within the English instruction subscale showed DIF. These ask if students discussed connections between reading and real-life people or situations, how culture, time, or place affect an author's writing, and if students rewrite a paper or essay in response to comments. Most items in the math subscale showed DIF. The item that did not show DIF asked if students write a math problem for other students to solve.

Table 4: β_2(Group) Estimates for all 22 items with Differential Item Functioning

Item Label	N	β_2(Group)[1]	Odds β_2(Group)
Safety2	9,971	0.31	1.36
Safety3	9,976	0.30	1.35
Safety5	10,074	-0.25	0.78
Trust1	10,111	-0.32	0.73
Trust3	9,946	-0.42	0.66
Trust4	9,922	-0.27	0.77
Trust5	9,972	-0.28	0.75
Personalism2	9,663	0.20	1.22
Personalism4	9,676	0.29	1.33
Personalism5	9,648	0.41	1.51
Support1	9,629	-0.40	0.67
Support2	9,506	-0.51	0.60
Support3	9,475	-0.63	0.53
Support4	9,464	-0.70	0.50
Clarity4	9,581	0.18	1.19
English2	9,537	0.25	1.28
English3	9,540	0.13	1.14
English5	9,542	0.14	1.15
Math1	9,412	0.28	1.32
Math2	9,264	0.24	1.28
Math3	9,290	0.29	1.34
Math4	9,276	0.24	1.27

Note: β_2 (Group) = Grouping variable (1 = 4th or 5th graders, 0 = 7th graders); N = Item sample size.

[1]Since DIF was detected in these items, all estimates for β_2(Group) are statistically significant with a p value lower than .01.

Of the 22 items with DIF 13 items favored the focal group, or 4th and 5th grade students. Within the safety subscale, two items favored 4th and 5th graders while one favored the reference group of 7th graders. All five items in the student-teacher trust subscale favored 7th graders. Conversely, the three academic personalism items favored younger students. The last subscale, peer support for academic work, had all items that favored 7th grade students. All items under the ambitious instruction construct subscale favored the focal group.

Hierarchical Linear Model

As seen in Table 5, this sample was primarily non-white (85.6%) and economically disadvantaged (72.3%). A majority of schools had a student body primarily composed of students of color (M = .87, SD = .18) and economically disadvantaged students (M = .71, SD = .23). In addition, roughly 40% of schools had K through 5th grade. Two schools with less than five student responses were excluded from this analysis.

Table 5: Descriptive Statistics 4th and 5th grade students

Student level variables	N	Min.	Max.	Mean	Std. Dev.
Gender (1 = Male, 0 = Female)	7,514	0	1	0.50	0.50
Student of Color (1 = Yes, 0 = No)	7,514	0	1	0.86	0.35
Economically Disadv. (1 = Yes, 0 = No)	7,294	0	1	0.72	0.45
5Essentials Score	7,514	-3.82	2.07	0.06	0.86
STAR Math Score	7,183	111	1,167	641.58	116.38
STAR Reading Score	7,245	41	1,346	473.29	219.39
School Level variables					
Percent Students of Color	104	0.29	1.00	0.87	0.18
Percent Economically Disadv.	104	0.04	0.92	0.71	0.23
Percent School K-5th grade	104	0	1	0.38	0.49
School 5Essentials Score	102	-0.64	0.63	0.05	0.23

Note: 5Essentials = 5Essentials of School Culture and Climate.

Table 6: Correlations of student- and school-level variables

Student-level variables	1	2		3
1. 5Essentials Student Score	-			
2. STAR Reading	0.03**	-		
3. STAR Math	0.09**	0.71**		-
School-level variables	4	5	6	7
4. Percent K-5th grade	-			
5. Percent Economically Disadv.	-0.04	-		
6. Percent Student of Color	0.00	.33**	-	
7. School 5Essentials Score	0.17	0.08	0.06	-

Note: 5Essentials = 5Essentials of School Culture and Climate. * = p < 0 .05, ** = p < 0.01

Table 7 and 8 provides the HLM results. Model 1, or the null model, results showed significant variance exists at the school-level for both reading and math scores. The ICC for math and reading is 0.22 and 0.20 respectively, indicating that about a fifth of total variation in achievement came from the school-level. Both are statistically significant for math, $\chi^2 = 1944.3$, df = 101, $p < 0.001$, and for reading, $\chi^2 = 2358.4$, df = 101, $p < 0.001$.

The fixed effect of student 5Essentials score in Model 2 was positive and statistically significant for math, t = 5.4, df = 6896, $p < 0.01$, and for reading, t = 2.96, df = 6957, $p < 0.01$. Since the fixed effect of the 5Essentials score was significant, the coefficient was put as a random effect in Model 3.

Table 7: Hierarchical Linear Model results of reading achievement for younger students

	Model 1		Model 2		Model 3	
Fixed Effects	Estimate	SE	Estimate	SE	Estimate	SE
Intercept γ_{00}	459.67**	10.31	463.45**	5.19	463.41**	5.27
Gender γ_{10}			-28.71**	5.11	-29.02**	5.10
ED γ_{20}			-64.35**	6.13	-64.62**	6.14
SoC γ_{30}			-88.29**	10.73	-87.43**	10.84
5Essentials γ_{40}			10.61**	3.58	11.68**	3.38
SchType γ_{01}			18.17	9.73	18.65	9.74
SchSoC γ_{02}			-333.69**	29.72	-331.73**	29.96
SchED γ_{03}			-19.15	25.74	-21.09	25.83
Sch5Essentials γ_{04}			44.50*	18.42	39.98*	18.65
5Essentials×SchType γ_{41}					-10.67	6.58
5Essentials×SchSoC γ_{42}					74.39**	19.37
5Essentials×SchED γ_{43}					-11.90	16.70
5Essentials×Sch5Essentials γ_{44}					-2.36	13.87
Random Effects	Component	χ^2 (df)	Component	χ^2(df)	Component	χ^2(df)
Intercept U_{0j}	10,308.0	2,358.4 (101)**	2,196.5	639.2 (97)**	2,155.6	623.5 (97)**
Student 5Essentials U_{4j}					405.0	156.8 (97)
Residual R_{ij}	36,843.1		35,172.3		34,805.7	
Model Information	Model 1		Model 2		Model 3	
N Level 1	7,242		7,063		7,063	
ICC	0.22		-		-	
Deviance	96,988.36		94,077.59		94,009.92	
ΔDeviance	-		2,910.77		67.66	

Note: * = p < .05, ** = p < .01; ED = Economically disadvantaged, SoC = Student of color, 5Essentials = Essentials of School Culture and Climate score, SchType = School type, SchSoC = school percentage of students of color, SchED = school percentage of students economically disadvantaged, Sch5Essentials = school average 5Essentials score, N = Sample size in model, ICC = Intra Class Correlation. All variables are centered around the grand mean.

The random effect of student 5Essentials score was statistically significant for reading, χ^2 = 156.8, df = 97, p <0.01, and for math, χ^2 = 151.2, df = 97, p < 0.01. In particular, the cross-level interaction for school-level 5Essentials score was not significant for either reading, t = -.17, df = 97, p = .87 or math, t = 8.11, df = 97, p = .30. This indicates the relationship between individual's perception of the learning environment and their reading or math achievement is not dependent on their school's overall learning environment score. The fixed effect of students' 5Essentials score in Model 3 was significant for reading, t = 3.45, df = 97, = < 0.001, and for math, t = 6.13, df = 97, p < 0.001. Students that perceive their school's learning environment to be positive had, on average, a positive impact on their math and reading achievement. Math and reading scores increased by 11.34 and 11.68 points for every one point they scored on the 5Essentials. A final, more parsimonious, model can be seen in Table 9 in the conclusion.

Table 8: Hierarchical Linear Model results of math achievement for younger students

	Model 1		Model 2		Model 3	
Fixed Effects	Estimate	SE	Estimate	SE	Estimate	SE
Intercept γ_{00}	632.74**	5.29	634.39**	3.30	634.70**	3.31
Gender γ_{10}			4.73	2.97	4.42	2.95
ED γ_{20}			-25.12**	2.93	-25.24**	2.94
SoC γ_{30}			-27.34**	3.98	-26.80**	4.02
5Essentials γ_{40}			10.99**	2.05	11.34**	1.85
SchType γ_{01}			11.60	6.66	11.53	6.63
SchSoC γ_{02}			-169.90**	19.09	-168.29**	19.18
SchED γ_{03}			11.95	18.60	10.92	18.67
Sch5Essentials γ_{04}			58.15**	14.04	56.76**	14.12
5Essentials×SchType γ_{41}					1.04	3.63
5Essentials×SchSoC γ_{42}					43.69**	10.14
5Essentials×SchED γ_{43}					-11.66	11.18
5Essentials×Sch5Essentials γ_{44}					-8.38	8.11
Random Effects	Component	χ^2 (df)	Component	χ^2 (df)	Component	χ^2 (df)
Intercept U_{0j}	2,691.7	1,944.3 (101)**	985.1	821.9 (97)**	966.3	786.3 (97)**
5Essentials U_{4j}					121.6	151.2 (97)**
Residual R_{ij}	10,840.7		10,527.7		10,413.0	
Model Information	Model 1		Model 2		Model 3	
N Level 1	7,180		7,002		7,002	
ICC	0.20		-		-	
Deviance	87,365.6		84,859.8		84,796.2	
ΔDeviance	-		2,505.9		63.6	

Note: * = p < .05, ** = p < .01; ED = Economically disadvantaged, SoC = Student of color, 5Essentials = Essentials of School Culture and Climate student score, SchType = School type, SchSoC = school percentage of students of color, SchED = school percentage of students economically disadvantaged, Sch5Essentials = school average 5Essentials score, N = Sample size in model, ICC = Intra Class Correlation. All variables are centered around the grand mean.

Conclusion and Discussion

The first goal of this study was to investigate younger students' perceptions of the school learning environment. Consistent with findings from previous research (Bear et al., 2011) this study shows that the perception of the school learning environment is multidimensional. Specifically, it can be characterized as a bifactor structure with a general construct and specific factors. Yet, contrary to previous research, measurement invariance does not hold among 4^{th}, 5^{th}, and 7^{th} grade students. The findings here show an equivalent factor structure, but the meaning and starting values of this construct differ across the two groups. As to what may have caused the lack of measurement invariance, the DIF analysis revealed a large number of items showed DIF. These items are unintentionally measuring something different.

Unlike their older peers, how younger students form and handle their relationships with peers, teachers, and other aspects of school life are different. This could be attributed to developmental differences between younger and older students or differences between the structure of school life between these two groups. Since the measurement of these perceptions by the studied survey are not equivalent, comparing younger and older students view of the culture and climate of the school based on this score will not be valid.

Table 9: Final HLM estimates predicting math and reading achievement for younger learners

	Math		*Reading*	
Fixed Effects	Estimate	SE	Estimate	SE
Intercept γ_{00}	634.23**	3.31	463.23**	5.19
Gender γ_{10}	4.40	2.94	-29.05**	5.09
ED γ_{20}	-25.29**	2.94	-64.56**	6.13
SoC γ_{30}	-26.83**	4.04	-87.53**	10.85
5Essentials $\gamma_{40}{}^{+}$	11.31**	1.89	11.56**	3.45
SchType γ_{01}	11.66	6.60	14.84	9.46
SchSoC γ_{02}	-168.38**	19.02	-332.12**	30.11
SchED γ_{03}	8.54	18.07	-23.41	26.48
Sch5Essentials γ_{04}	67.00**	13.95	55.12**	18.64
5Essentials×SchSoC γ_{42}	37.29**	7.72	66.78**	18.26
Random Effects	Component	χ^2 (df)	Component	χ^2 (df)
Intercept U_{0j}	986.78	831.88 (97)**	2,194.41	643.90 (97)**
5Essentials U_{4j}	123.65	155.79 (100)**	439.02	161.24 (100)**
Residual R_{ij}	10,411.78		34,788.61	
Model Information	*Math*		*Reading*	
N Level 1	7,002		7,063	
Deviance	84,818.91		94,032.29	

Note: * = p < .05, ** = p < .01; ED = Economically disadvantaged, SoC = Student of color, 5Essentials = Essentials of School Culture and Climate student score, SchType = School type, SchSoC = school percentage of students of color, SchED = school percentage of students economically disadvantaged, Sch5Essentials = school average 5Essentials score, N = Sample size in model.

$^{+}$ = 5Essentials γ_{40} was group mean center. All other variables are centered around the grand mean.

The second objective of this study was to explore how this perception may be associated with academic achievement. Like middle and high school students, this study found that the perception of the school learning environment was also associated with academic achievement for younger learners. Younger students with positive perceptions of their school's learning environment have higher math and reading scores. On average, they gain roughly 11 points on reading or math for every extra point they scored on the 5Essentials. This implies schools, educators, and school leaders that are better able to cultivate a positive learning environment may positively impact their younger student body. Thus, establishing an environment where students feel they can be successful can promote learning for younger students.

Limitations

First, not all items on the student version of the 5Essentials survey were asked to younger and older learners. This led to a comparison of an incomplete model between these two groups, which may hinder the generalization of the findings.

Secondly, determining if measurement invariance is present can be difficult and complicated (Chen, 2007; Vandenberg & Lance, 2000). Conclusive criteria for measurement invariance are also hard to determine since more complex models with either many items or factors can negatively affect goodness-of-fit indexes (Cheung & Rensvold, 2002). Although not used, previous studies have used other standards for metric and scalar invariance to try and combat these inherent difficulties in measurement invariance testing (Bear et al., 2011; Yang et al., 2013). Yet, caution is needed when using these additional standards since there are many factors that can influence incremental differences in the CFI and RMSEA (Chen, 2007). Considering these warnings, describing changes in these indexes were not used since they are not as statistically sound as a chi-square difference test between models.

Another limitation is the sample may not represent each school well. Schools that are more organized usually survey students better, hence their sample is more representative. In less organized schools, school staff or students who are, or want to be, engaged may be more likely to participate, making their samples more prone to bias.

Future research

This study shows students with a more positive view for their school's learning environment tend to have higher achievement. Yet, the processes through which the culture and climate of a school is internalized within any given student is unclear (Berkowitz, Moore, Astor, & Benbenishty, 2017). Future research may look into the social processes that take place in the encoding of culture or climate (Lizardo, 2016). Studies like this may explain why these individual-level perceptions are related to academic achievement.

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Appendix

Table 10: 5Essentials of School Culture and Climate Student Survey Questions

Supportive Environment

Safety	How safe do you feel:	1. In the hallways of the school. 2. In the bathrooms of the school. 3. Outside or around the school. 4. Traveling between home and school. 5. In your classes.
	Response Categories	Not safe (1), Somewhat Safe (2), Mostly Safe (3), Very Safe (4)
Student-Teacher Trust	How much do you agree with the follow:	1. When my teachers tell me not to do something, I know they have a good reason. 2. I feel safe and comfortable with my teachers at this school. 3. My teachers always keep their promises. 4. My teachers will always listen to students' ideas. 5. My teachers treat me with respect.
	Response Categories	Strongly Disagree (1), Disagree (2), Agree (3), Strongly Agree (4)
Academic Personalism	The teacher for this class:	1. Helps me catch up if I am behind. 2. Is willing to give extra help on schoolwork if I need it. 3. Notices if I have trouble learning something. 4. Gives me specific suggestions about how I can improve my work in this class. 5. Explains things in a different way if I don't understand something in class.
	Response Categories	Strongly Disagree (1), Disagree (2), Agree (3), Strongly Agree (4)
Academic Press	How much do you agree with the following statements:	1. This class really makes me think. 2. I'm really learning a lot in this class. 3. Expects everyone to work hard. 4. Expects me to do my best all the time. 5. Wants us to become better thinkers, not just memorize things.
	Response categories:	Strongly Disagree (1), Disagree (2), Agree (3), Strongly Agree (4)
	How often:	6. Are you challenged? 7. Do you have to work hard to do well? 8. Does the teacher ask difficult questions on tests? 9. Does the teacher ask difficult questions in class?
	Response Categories:	Never (1), Once in a while (2), Most of the time (3), All of the time (4)
Peer Support	How many students in your class:	1. Feel it is important to come to school every day. 2. Feel it is important to pay attention in class. 3. Think doing homework is important. 4. Try hard to get good grades.
	Response Categories	None (1), A few (2), Some (3), About half (4), Most (5), All (6)

(*Continued*)

Ambitious Instruction (*Continued*)

Course Clarity	How much do you agree with the following statements	1. I learn a lot from feedback on my work 2. The homework assignments help me to learn the course material 3. The work we do in class is good preparation for the test 4. I know what my teacher wants me to learn in this class 5. It's clear to me what I need to do to get a good grade
	Response Categories	Strongly Disagree (1), Disagree (2), Agree (3), Strongly Agree (4)
English Instruction	In your English/Literature class this year, how often do you do the following:	1. Debate the meaning of a reading 2. Discuss connections between a reading and real-life people or situations 3. Discuss how culture, time, or place affects an author's writing 4. Improve a piece of writing as a class or with partners 5. Rewrite a paper or essay in response to comments
	Response categories	Never (1), Once or twice a semester (2), once or twice a month (3), once or twice a week (4), almost every day (5)
Math Instruction	In your Math class this year, how often do you do the following:	1. Apply math to situations in life outside of school 2. Discuss possible solutions to problems with other students 3. Explain how you solved a problem to the class 4. Write a few sentences to explain how you solved a math problem 5. Write a math problem for other students to solve
	Response categories	Never (1), Once or twice a semester (2), once or twice a month (3), once or twice a week (4), almost every day (5)