

The Mediating Role of Anti-Bullying Administrative Measures in the Relationship between Bullying and Students' Core Competencies

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Abstract. *This research evaluates the role of school administrative measures (including creating a greater school belonging and paying attention to student attendance) as independent variables and their resulting core competencies through the mediator of students' experience with school bullying. This study adopted a multi-level mediation model to empirically analyze data from middle school students and school administration in four Chinese provinces based on the 2015 Programme for International Student Assessment (PISA). Data were collected from a total of 9,060 students and 260 administrative staff. The results were: (i) Relational bullying was significantly and negatively correlated with the three core competencies, although no significant impact was found for either verbal or physical bullying; (ii) Schools which were successful in creating a more positive environment, including greater school belonging and greater attention to students' attendance, demonstrated lower levels of relational bullying; (iii) In terms of school-level variables, a greater sense of shared belonging had a direct effect on improving student performance on math and science competencies, while greater attention to students' attendance was associated with higher student scores on all three core competencies; (iv) Furthermore, school-level variables, including the sense of shared belonging and greater attention to students' attendance demonstrated a positive indirect effect on students' core competencies through the mediating effect of reduced relational bullying.*

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Introduction

GLOBALLY, educational administrators and policymakers hold the standardized scores reported by the Programme for International Student Assessment (PISA) in high regard, placing a strong emphasis on PISA's measurement of core competencies, holding these scores as indicators of school success (Wu, 2013). The emphasis of student performance on PISA, thus, reflects the role that school administrators must play in the cultivation of students' core competencies. However, PISA not only evaluates the core competencies of 15-year-old middle school students across the globe (in terms of mathematics, reading, and science), but also collects a wide range of relevant background information, including student- and school-level factors which may influence student performance. As such, PISA data serves as a valuable source for educational researchers in empirically investigating the potential relationships between performance on core competencies and other relevant background factors, the results of which can reveal, to a certain degree, which factors related to school administration demonstrate the greatest influence on students' academic performance in terms of the three core competencies.

Given the availability of student- and school-level background data, some Chinese researchers have already begun to conduct studies using a variety of items from PISA datasets. In the case of students' science competencies, Zhao, Guo, and Jiao (2017) utilized multi-level analysis to evaluate PISA data, demonstrating the significant and positive effects of school-level variables, including the provision of creative extracurricular activities, scientific resources, and greater cooperation among science teachers. In terms of reading, science, and mathematics competencies, Chen (2017) found significant effects for non-cognitive factors, including achievement motivation, parental emotional support, reduced test anxiety, and a sense of belonging to the school. Although a sense of belonging to the school, as measured in Chen's (2017) study, was based on individual students' perceptions, the construct of "belongingness" can also serve as a higher-level (school-level) variable in multi-level modeling, as in the shared perceptions among students of the same school. In this manner, the use of school-level belongingness can better reflect the degree to which school administration is effective in developing an appropriate environment for teaching and learning.

While the aforementioned studies have evaluated the relationship between school measure variables, such as the provision of activities and resources, with students' performance on core competencies, the relationships among school bullying, school administration efforts and students' core competencies have not yet been empirically evaluated. Therefore, this study utilized the PISA data released in 2015 to empirically explore the relationships among school administration factors, student bullying, and the three core competencies (mathematics, reading, and science). Variables belonging to different levels, both school-level and student-level, were included in the multi-level mediation modeling analysis of the present analysis. The aim of this analysis was to evaluate how school-level variables, including school administration, can influence student-level variables, such as performance on core competencies, by considering the

mediating role of school bullying. As such, this study contributes a new perspective on the prevention of school bullying that, in turn, has the potential for improving adolescent students' performance in terms of core competencies.

Independent Variables: Creating a Sense of Shared Belonging and Attention to Student Attendance

Based on the limitations facing existing studies, which were based on single-level models, this study adopted a multi-level analysis, including mediation, using aggregated data from the 2015 PISA datasets. This data was used to generate school-level independent variables including a) creating a sense of shared belonging and b) attention to student attendance. Since these two school-level factors reflect the administrative actions or measures implemented by school staff, they are highly practical in nature and can be generalized to other contexts. Based on preliminary analytical results adopting single-level analysis, these two variables were supported as relevant to both students' performance on core competencies and school bullying, serving as the basis for the decision to further test these relationships using a multi-level mediation model.

In terms of the sense of shared belonging to one's school, Chen (2017) demonstrated that higher levels for the sense of shared belonging were associated with higher core competencies for adolescent students. Furthermore, students' perceived sense of belonging to the school was negatively associated with reported bullying (Chen & Zhi, 2017; Didaskalou et al., 2017). In terms of student attendance, research has demonstrated that student truancy has negative impacts on academic achievement and is associated with reported bullying on campus (Gastic, 2008). Based on the aforementioned studies, administrative measures that both develop a sense of shared belonging and greater attention to student attendance are relevant to the incidence of school bullying as well as student performance on core competencies.

Mediator: School Bullying

The results of a meta-analysis have shown that school bullying has a significant negative effect on academic achievement (Nakamoto & Schwartz, 2012). Empirical evidence supporting the negative influence of bullying served as a basis for this study in selecting school bullying as a mediating variable. Moreover, the school bullying is both a new item for PISA, added for the first time in 2015 (OECD, 2017a), and an increasingly prevalent issue in Chinese education in recent years (Yang et al., 2017; Li, 2017; Wang et al., 2015). According to the OECD (2017a), after controlling for the influence of the overall socio-economic status of a school's families, students who report being more frequently bullied at school scored 47% lower on the science competency exam as compared with students who reported infrequent bullying.

Given the fact that peer victimization has a profound impact on student learning performance, the PISA report (OECD, 2017a) urges schools to take concrete measures to curb school bullying, adding that school bullying directly and negatively impacts students' performance on core competency measures. Furthermore, the report

(OECD, 2017a) suggests that, in order to improve campus safety and enhance students' potential learning success, schools must actively enact student management policies. Based on this logic, the mediating role of school management efforts is seen as a means to indirectly improve students' performance on core competencies by directly reducing school bullying.

Following the release of the 2015 PISA data and report, some studies in China have conducted secondary data analysis on school bullying-related topics (e.g., Chen & Zhi, 2017; Huang, 2017). However, thus far, no studies have adopted a multi-level mediation model including the school-level administration variables of (i) developing a sense of shared belonging and (ii) attention to student attendance.

Research Questions

The purpose of this study was to investigate the degree to which school-level independent variables indirectly influence students' performance on core competencies through the mediation of the student-level variable of school bullying. This study utilized raw data from students and administrators in mainland China from the 2015 PISA datasets in the development of a multi-level mediation model. Based on recommended procedures for examining mediation effects in multi-level models (Wen & Chiou, 2009), the research questions of this study are stated as follows:

RQ1: Does school bullying significantly influence students' performance in terms of reading, mathematics, and science competencies?

RQ2: Does an administrative approach that seeks to develop a sense of shared belonging and pays greater attention to student attendance significantly reduce students' experiences of school bullying?

RQ3: Does the reported sense of shared belonging and student attendance significantly explain differences among students in terms of performance on reading, mathematics, and science competencies?

RQ4: Does a sense of shared belonging and student attendance have a significant indirect effect on students' performance on reading, mathematics, and science competencies through the mediating factor of school bullying?

Multi-Level Modeling Procedures

Assuming that school administrative policies and procedures will directly reduce school bullying which, in turn, will indirectly influence students' performance on core competencies, a fundamental feature of the research model was the relationship between school administration factors and school bullying. In order to clarify the relationship between these two factors, related variables were first controlled. The following sections discuss the control variables included in the multi-level model and research hypotheses corresponding to the paths of the multi-level model.

Control Variables

Based on a review of school bullying research, certain student-level and school-level demographic variables have been found to influence the occurrence of school bullying. However, since many of these variables were not the focus of the model developed in this study, they are treated as control variables. In terms of student-level variables, gender, grade, and family socioeconomic status were included as control variables. Based on the findings of Huang (2017), who evaluated 2015 PISA data from mainland China, boys, and lower grade students were more likely to be victims of bullying. Furthermore, Jansen et al. (2012) reported that adolescents in the Netherlands from families of lower social status reported a higher proportion of physical and psychological bullying symptoms and, as such, more strongly experienced the negative effects of school bullying.

In terms of school-level variables, the school's overall family socioeconomic status, school size, and location of the school district were included as control variables in the multi-level model. The school's overall family socioeconomic status was necessarily included based on the results of a multi-level study of high school students from various countries, which revealed that large gaps in the levels of economic purchasing power among families in a school district were associated with more frequent occurrences of school bullying (Due et al., 2009). Based on the recommendations of Due et al.'s study, a school's overall family socioeconomic status, as a school-level variable, must be controlled. The size and location of schools were also evaluated by the model, in reference to Betts' (2014) investigation into the relationship between the size and location of schools and differences in the occurrence of school bullying, with students from larger schools demonstrating greater vulnerability to physical bullying, and location (urban vs. rural) showing no significant influence. Thus, although there no significant impact on school location was noted in Betts' (2014) study, due to the large educational gaps between China's urban and rural areas, it was considered prudent to incorporate school location in the model as a school-level control variable.

Research Hypotheses

The research hypotheses proposed by this study are in reference to the limited findings of prior single-level studies. The expansion of the proposed model to a methodology adopting multi-level analysis was deemed prudent, given the potential contribution of both the student-level and school-level variables discussed in previous sections of this paper.

Sense of Shared Belonging

The first school-level variable included in the multi-level model was "sense of shared belonging." A sense of shared belonging can be conceptualized as a student-level constructor, in the case of this study, computed as a school-level variable through the aggregation of data from a school's entire student population. Thus, as a school-level variable, the interpretation of "sense of shared belonging" differs from the student-level construct in that, in addition to representing the shared and collective perceptions regarding the school environment by a school's student population, it can also reflect the school's overall administrative efforts towards the development of an appropriate envi-

ronment for teaching and learning, including care for and acceptance of students (Freeman et al., 2007). While past empirical studies have evaluated sense of belonging as a student-level variable (Chen, 2017; Chen & Zhi, 2017), in order to evaluate the efficacy of school administration in anti-bullying efforts (Stewart, 2008), a sense of shared belonging was set as a school-level construct in this study. Furthermore, it should be noted that Liu and Liu's (2011) follow-up study found no significant correlation between students' sense of belonging (as a student-level variable) and academic achievement, after differentiating initial stage and linear growth values. As such, this study adopts students' sense of shared belonging as an emotional factor, with the influence of emotional factors on academic achievement operating as an indirect, rather than direct, effect.

Based on the findings of previous studies investigating students' sense of belonging, it seems more likely that a sense of shared belonging, as a school-level variable, can best reflect the degree to which school administrators actively and effectively develop an environment wherein students develop positive feelings towards the school, leading to better academic performance. However, although the school-level sense of shared belonging influences the core competencies of individual students across levels, the possible mediating effects have yet to be investigated. As Liu and Liu (2011) conclude, students' sense of belonging serves as an emotional factor that indirectly influences academic achievement through other mediating variables (Dong & Yu, 2010). Thus, this study hypothesizes that a school-level sense of shared belonging will influence students' performance in terms of PISA core competencies (RQ3).

As such, this study proposed school bullying as a potential mediator for the influence of a sense of shared belonging on students' core competencies. Specifically, victims of bullying often feel a lack of acceptance within a school's environment and, as a result, fail to seek assistance, retreat from school life, and demonstrate lower levels of confidence, resulting in an increased likelihood of being bullied further, resulting in a long-term vicious cycle (Chen & Zhi, 2017; Didaskalou et al., 2017). Moreover, a significant correlation exists between the experience of being bullied and low academic achievement, based on the meta-analysis of Nakamoto and Schwartz (2010). Thus, this study hypothesizes that bullying directly impacts students' performance on core competencies (RQ1).

From the previously noted single-level empirical studies, students' sense of shared belonging and school bullying appear to be causally linked, making it difficult to determine which variables are independent and which are mediators. However, by aggregating individual data in computing a school-level variable for a sense of shared belonging and adopting bullying as a student-level variable, the independent variable and mediating variable can be more clearly assessed. From the perspective of multi-level mediation analysis, higher-level (school-level) variables are generally adopted as independent variables and are hypothesized to influence the lower-level (student-level) variables (Wen & Ye, 2014). Therefore, the "sense of shared belonging" as a school-level was adopted as the independent variable and school bullying as the mediating variable. After determining the possible paths among the three variables (students' sense of shared belonging, school bullying, and student core competencies), we hypothesized

that school administrators, by actively developing students' sense of shared belonging would a) directly prevent school bullying (RQ2) while b) indirectly improving students' core competencies (RQ4).

Attention to Student Attendance

Based on PISA data, the factor regarding the school administration's efforts towards "attention to student attendance" is evaluating using three items evaluating: students' lateness, skipped classes, and truancy. These are student-level variables in the original 2015 PISA datasets but were aggregated as a school-level variable reflecting the administration's attentiveness to school attendance. Students' timeliness and attendance are undoubtedly necessary to ensure the quality of learning. If students are not willing to attend classes or are truant, they are not likely to perform well academically (Fang, 2007). As such, paying closer attention to students' attendance in one measure by which school administrators can promote students' attendance classes and timeliness, factors assumed to have a direct effect on students' performance on core competencies. Thus, this study hypothesizes that school-level sense of attention to student attendance will demonstrate an influence on students' performance in terms of PISA core competencies (RQ3).

Furthermore, the PISA report (OECD, 2017a) suggests that when students realize that the school will attentively enforce school rules, bullying events will be reduced. Therefore, it is possible that more attentive student management by the administration, as a school-level variable, can deter the occurrence of school violence, reduce opportunities for students to experience bullying, and have a positive indirect effect on students' core competencies. Thus, in the multi-level model, school bullying likewise serves as a mediator between school administrators' efforts to enforce student attendance and students' resulting performance on core competencies.

Close relationships have been found among school bullying, student attendance, and academic achievement (Gastic, 2008). In order to avoid bullying, students may protect themselves by avoiding the school environment. However, by skipping classes, such students fail to keep up with lessons, resulting in poor academic performance. The research of Zhao and Zhu (2012), targeting both juvenile offenders and non-offending middle school students, found that skipping classes was closely associated with peer victimization, demonstrating that skipping classes weakened the relationship between students and the school, leaving them vulnerable to negative behaviors. As such, skipping classes has a mutually causal relationship with school bullying, wherein bullied students attempt to skip classes to avoid peer victimization but, by skipping classes, lose their connection with the school, preventing victimized students from obtaining assistance and continuing to suffer bullying. Thus, this study hypothesizes that bullying directly influences students' performance on core competencies (RQ1).

As previously noted, if the single-level analysis is adopted, it is difficult to determine the independent variable from a bi-directional correlation. However, by aggregating attendance as a higher-level (school-level) variable, the independent and mediating variable can be clearly distinguished. Since the school-level factor of attention to

students' attendance, as defined in this study, reflects the attentiveness of the school's administration in the implementation and enforcement of school rules, this variable serves as a higher-level, school-level variable and an independent variable in evaluating the effectiveness of school bullying prevention. Therefore, this study hypothesizes that if the school administration pays attention to students' attendance through a more attentive administrative approach, they will demonstrate that the school attaches importance to students' learning, resulting in a strengthened relationship between students and the school and more effective prevention of school bullying. In this way, an attentive school administration, which pays attention to students' attendance, mediated by a decrease in school bullying, has the potential to improve students' core competencies. After determining the possible paths among the three variables (attention to school attendance, school bullying, and student core competencies), we hypothesized that school administrators, by paying more attention to student's attendance would a) directly prevent school bullying (RQ2) while b) indirectly improving students' core competencies (RQ4).

Research Methods

Data Source

Variables from the 2015 PISA dataset were selected for analysis, including background information on students and school administration. These samples represented the Chinese provinces of Beijing, Shanghai, Jiangsu, and Guangdong. Data from a total of 9,841 students and 268 schools (with each school represented by one school administrator) were analyzed. After excluding missing data, the number of valid subjects included 9,060 students (52.4% male and 47.6% female) and 260 administrative staff. From among these schools, schools with a total student population of less than 1,600 accounted for 59.2% of schools, while schools with more than 1,600 students accounted for 41.8% of total schools. Schools located in towns and small cities accounted for 50.8% of the total, with schools located in large cities accounting for 37.3% of the total, and schools in rural areas accounting for 11.9% of total schools.

Variables in the Multi-Level Model and Corresponding 2015 PISA Data

This section lists the variables included in the research model and provides examples of items from the corresponding 2015 PISA dataset (see **Table 1**). Included in **Table 1** is a column entitled "Variables" which includes the variables of the multi-level mediation model, including dependent and independent variables, a mediator, and control variables belonging to either the student- or school level. The column entitled "Corresponding 2015 PISA data" includes items from the 2015 PISA dataset used in computing model variables (including both measurement indicators and the original items on which these measurement indicators were based). Derived variables included in the model include two generated from the PISA data, including the original PISA item of

Table 1. The Variables of the Model and the Corresponding Data of PISA 2015.

Variables		Corresponding data	
		Measurement Indicators	Original PISA Items
Dependent Variables (student-level)	Mathematics, reading, and science competencies	Ten plausible values (PV) for each competency	Mathematics: PV1MATH - PV10MATH Reading: PV1READ - PV10READ Science: PV1SCIE - PV10SCIE
		Sense of shared belonging	The aggregate of the variable "Belong" for students from the same school
Independent Variables (school-level)*	Attention to students' attendance	The aggregate of the number of days students are late for school each week	Belong: ST034Q01TA-ST034Q06TA
		The aggregate of the number of days students skip class each week	Late for school: ST062Q03TA
		The aggregate of the number of days students are truant each week	Skipping classes: ST062Q02TA
			Truancy: ST062Q01TA
Mediator (student-level)	Being bullied	Verbal bullying: Mean PISA verbal bullying scores.	Verbal bullying: ST038Q04NA and 05NA
		Relational bullying: Mean PISA relational bullying scores.	Relational bullying: ST038Q03NA and 08NA
		Physical bullying: Mean PISA physical bullying scores.	Physical bullying: ST038Q06NA and 07NA
Control Variables (student-level)	Gender	Male or female based on PISA codes	Gender: ST004D01T
	Grade	Grade based on PISA codes	Grade: ST001D01T
	Family socioeconomic status	"ESCS"	Weighted "HOMEPOS", "HISEI" and "PADER" values
Control Variables (school-level)	School size	"SCHSIZE"	Addition of the number of SC002Q01TA (boys) and SC002Q02TA (girls)
	Type of school	Private v.s. public from PISA codes	SC013Q01 (1 = private school, 3 = public school)
	School location	Location-based on PISA codes	SC001Q01 (1-5 representing the village, small town, town, city, and big city, respectively)
	School family socioeconomic status	The aggregate of the "ESCS" value for all students from the same school	

* Averaging scores for students in the same school and aggregate them as a school-level variable

Note 1: The variable names in the table are exactly the same as those in the PISA 2015 data file.

Note 2: According to the PISA 2015 manual, in order to correctly analyze the PV values, a one-time analysis of the ten PVs in terms of the mean value is not recommended. Rather, each PV must first be analyzed and then combined with the results of the other 10 PV values in order to establish significance. This study utilized HLM software to perform the above-mentioned processes.

Note 3: In addition to variables such as the size, type, and location of the school, other school-level independent variables and control variables were aggregated from student-level variables.

Note 4: For the calculation of family socioeconomic status, the following items were included: "HOMEPOS" (home possessions), "HISEI" (highest parental occupation), and "PADER" (parental education).

“Belong” (representing the sense of shared belonging) and “ESCS” (representing the overall school families’ socioeconomic status). The technical manual for PISA (OECD, 2017b) stated that the derived variables are scale scores generated by computing original items through item response theory, with these resulting derived scores being suitable for using for direct comparisons among OECD member countries.

Data Analysis

Data analysis consists of two parts: descriptive statistics and multi-level mediation modeling. In terms of descriptive statistics, since the PISA data involves ten plausible values (PVs) for estimating students’ core competencies, these values cannot be directly processed using SPSS statistical software. Therefore, a syntax was first generated using IDB Analyzer 4.0 (IEA, 2018), and then executed using SPSS 22.0 to compute descriptive statistics. For the multi-level mediation model, we used HLM 6.0 to analyze the data, following the suggestions provided by the PISA technical manual (OECD, 2017b) to weigh variables at the student-level and school-level, utilizing the values of “W_FSTUWT” (Final student weight) and “W_SCHGRN” (Final school weight). In terms of the steps involved in conducting multi-level mediation modeling, this study followed the recommended procedures of Wen and Chiou (2009) to address the four research questions.

- Step 1 (RQ1). This study first evaluated the coefficient for the influence of the mediator on the dependent variables. The dependent variables included students’ mathematics, reading, and science competencies. The mediator included three types of school bullying (verbal, relational, and physical). Based on the results of the first step, we retained the bullying types with statistically significant coefficients before continuing to conduct a follow-up analysis.
- Step 2 (RQ2). Next, we computed the coefficient for the influence of the school-level independent variables on the mediator variable of school bullying. The school-level variables in this study were a) sense of shared belonging and b) attention to students’ attendance. In terms of attentive school administration efforts, which pay attention to students’ attendance, three items were included: “late for class,” “skipping classes,” and “truancy.” In Step 2, we tested the impact of these two school management measures on the mediator (school bullying) and retained those context variables with statistically significant influence.
- Step 3 (RQ3). The third step was to test the coefficient for the influence of the school-level variables on the dependent variables (core competencies). From Step 2, only school-level variables with significant coefficients were used in testing their effects on the dependent variables. It should be noted that only school-level variables with coefficients reaching statistical significance in Step 3 were then retained for further analysis in Step 4.
- Step 4 (RQ4). The final step was to confirm whether or not a mediating effect existed within the model. The criterion for a mediation effect is that when the school-level variables and the mediator are included in the same model, the coefficient for the influence of the school-level variables on the dependent variables must be lower

than the coefficient when the mediator is not included. In this case, if the coefficient for the influence of the school-level variables on the dependent variables (core competencies) was not significant, and the influence of the mediator on the dependent variables was significant, a complete mediating effect would be indicated. However, if the coefficient for the influence of the school-level variables on the dependent variables (core competencies) still reached a statistically significant level, a partial mediating effect would be indicated.

Results

Descriptive Statistics

The descriptive statistics are provided in **Table 2**. In terms of school-level variables, the average school size was 1,476 students ($SD = 1,445$). The mean for overall school families' socio-economic status was -1.16 ($SD = 0.76$), while the mean shared sense of shared belonging was -0.30 ($SD = 0.21$). Mean values were also calculated for being late for school ($Mean = 1.52$, $SD = 0.24$), skipping classes ($Mean = 1.11$, $SD = 0.11$), and truancy ($Mean = 1.03$, $SD = 0.05$), which indicated that, on average, less than two absences or late arrivals were observed over the most recent two weeks. The average value for student-level family socioeconomic status was -1.04 ($SD = 1.11$). Since this value was negative, it suggests that the family socioeconomic status of students was lower than the average for students in other OECD countries. Among the three core competencies, the mathematics competence was the highest ($Mean = 538.38$, $SD = 104.19$), followed by science competence ($Mean = 524.38$, $SD = 101.84$), and reading competence ($Mean = 501.18$, $SD = 106.87$). The mean value for verbal bullying was 1.30 ($SD = 0.56$) and relational bullying was 1.30 ($SD = 0.59$). The mean for physical bullying was 1.35 ($SD = 0.56$). Given the above values and the variation among different types of bullying, student-level bullying ranged widely among schools, from situations where students reported no bullied to schools where students reported experiencing bullying several times a year.

Mediation Effects

The analytical results of multi-level mediation modeling are provided in **Table 3**. In order to confirm that the intraclass correlation coefficient (ICC) and the variation components met the requirements of multi-level analysis, we first tested a null model including the dependent variables of the three core competencies (mathematics, reading, and science). The results demonstrated that the ICC for mathematics, reading and science competencies were 48%, 51%, and 49%, respectively, and that the various components of these three variables were significantly different from zero, which indicated that the core competencies for students in the same school were similar, with significant differences between schools. Since the assumptions required for multi-level mediation modeling were met, this analysis was adopted to evaluate the nested data derived from the 2015 PISA through non-independent sampling. In addition, based on the recom-

Table 2. Descriptive Statistics.

	Mean	SD
School-level		
School size	1,476	1,445
School-level family socio-economic status (ESCS)	-1.16	0.76
Sense of shared belonging	-0.30	0.21
Late for school	1.52	0.24
Skipping classes	1.11	0.11
Truancy	1.03	0.05
Student-level		
Family socioeconomic status (ESCS)	-1.04	1.11
Mathematics competency	538.38	104.19
Reading competency	501.18	106.87
Science competency	524.38	101.84
Verbal bullying	1.30	0.56
Relational bullying	1.30	0.59
Physical bullying	1.35	0.56

recommendations of Wen and Chiou (2009) school-level variables adopted a fixed slope and grand mean-centered when the multi-level mediation model was tested.

The Relationship between School Bullying and the Core Competencies

The multi-level model equations are shown as follows. The results demonstrate that when student- and school-level control variables were included, only relational bullying was shown to negatively influence all three core competencies (with a coefficient for mathematical competency of $\gamma_{50} = -8.53$, $p = 0.01$; a coefficient for reading competency of $\gamma_{50} = -6.21$, $p = 0.04$; and a coefficient for science competency of $\gamma_{50} = -6.93$, $p = 0.01$). Verbal bullying and physical bullying showed no significant effects on the three core competencies.

Student-level (Equation 1-1)

$$\text{Core Competency}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socioeconomic status}_{ij}) + \beta_{4j}(\text{Verbal bullying}_{ij}) + \beta_{5j}(\text{Relational bullying}_{ij}) + \beta_{6j}(\text{Physical bullying}_{ij}) + \gamma_{ij}$$

School level (Equation 1-2)

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \gamma_{04}(\text{School-level socioeconomic status}_j) + U_{0j}; \beta_{1j} = \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30}; \beta_{4j} = \gamma_{40}; \beta_{5j} = \gamma_{50}; \beta_{6j} = \gamma_{60}$$

The Relationship between School Administrative Measures and School Bullying

Table 3. Multi-Level Mediation Model.

Dependent Variable	Null Model	Step 1						Step 2			Step 3			Step 4					
	CC	CC		RB		CC		CC (Without Mediator)			CC (With Mediator)								
	M	R	S	M	R	S	M	R	S	M	R	S	M	R	S				
Fixed Effects																			
γ00		267.25**	229.48**	195.53**	1.83**	223.56**	203.88**	165.85**	241.26** ^a	246.92** ^b	213.30**	172.71**	246.09**	216.19	180.63**	176.19**			
γ01	School type	-18.41	-15.35	-10.13	0.02	-12.78	-11.16	-5.12	-11.22 a	-17.98 b	-14.86 b	-3.49 a	-10.94 a	-14.52 b	-3.31 a	-9.16 b			
γ02	Size	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00 a	0.00 b	0.00 b	0.00 a	0.00 a	0.00 b	0.00 a	0.00 b			
γ03	Location	-5.03	-0.05	-2.09	0.02	-3.35	1.35	-0.47	-3.95 a	-4.11 b	0.81 b	-1.07 a	-3.76 a	0.94 b	-0.94 a	-0.96 b			
γ04	School-level ESCS	62.03**	63.05**	62.47**	0.01	42.02**	46.89**	43.78**	46.51** ^a	51.76** ^b	53.86** ^b	48.31** ^a	46.49** ^a	53.61** ^b	48.30** ^a	51.79** ^b			
γ05	School-level shared belonging				-0.33**	62.82**	45.04	53.51*	90.85** ^a			82.06** ^a	87.59** ^a		79.76** ^a				
γ06	Late for class				0.02														
γ07	Skipping classes				0.27*	-182.27**	-164.70**	-185.00**	-210.34** ^b	-184.86** ^b	-208.91** ^b	-206.01** ^b	-182.05** ^b	-205.85** ^b					
γ08	Truancy				0.40														
γ10	Gender	9.28*	-13.83**	13.02**	0.12**	8.24*	-14.43**		8.31* ^a	8.26* ^b	-14.41** ^b	12.48* ^a	9.23* ^a	-13.81** ^b	13.13** ^a	13.09** ^b			
γ20	Grade	32.38**	34.26**	36.16**	-0.08**	34.46**	35.73**		33.95** ^a	33.95** ^b	35.37** ^b	37.42** ^a	33.18** ^a	34.87** ^b	36.87** ^a	36.83** ^b			
γ30	ESCS	6.83*	8.48**	5.94**	-0.01	6.89**	8.50**		6.90** ^a	6.91** ^b	8.51** ^b	5.97** ^a	6.80** ^a	8.44** ^b	5.90** ^a	5.91** ^b			
γ40	Verbal bullying	-1.67	-0.72	-1.19															
γ50	Relational bullying	-8.53*	-6.21*	-6.93*								-8.26** ^a	-8.30** ^b	-5.38* ^b	-5.81* ^a	-5.86* ^b			
γ60	Physical bullying	2.29	2.25	3.30															
Random Effects																			
σ ² (Intragroup variation)	M: 5562.65 R: 5481.30 S: 5091.36	5282.33	5135.06	4757.59	0.36	5305.17	5144.49	4769.17	SB: 5304.63 SC: 5305.24	SC: 5144.62	SB: 4768.62 SC: 4769.43	SB: 5283.25 SC: 5283.85	SC: 5136.39	SB: 4759.05 SC: 4759.86					
τ00 (Intergroup variation)	M: 5145.82* R: 5667.24* S: 4901.72*	1849.56**	1648.24**	1466.85**	0.004*	1370.26**	1297.71**	1005.84**	SB: 1671.39** SC: 1469.10**	SC: 1344.84**	SB: 1315.21** SC: 1074.77**	SB: 1636.61** SC: 1435.53**	SC: 1324.72**	SB: 1292.61** SC: 1053.93**					

Note: CC: Core Competency; RB: Relational Bullying; M: Math; R: Reading; S: Science; SB: Shared belonging; SC: Skipping classes.
^{*}p < 0.05, ^{**}p < 0.01; ^a coefficient for the influence from sense of shared belonging to the school (school-level); ^b coefficient for the influence of skipping classes (school-level)

Based on the results of Step 1, only relational bullying had a significant effect on students' core competencies. Thus, only relational bullying was utilized to test the association between school administration measures and bullying. Based on Equations 2-1 and 2-2, the results demonstrate a significant and negative coefficient for sense of shared belonging ($\gamma_{05} = -0.33, p < 0.01$) and a significant and positive coefficient for skipping classes ($\gamma_{07} = 0.27, p = 0.03$). However, the coefficients for late for school and truancy were not significant. These results imply that the higher the sense of shared belonging (as an aggregate measure) and the more attentive the student administration was towards students' attendance (as evidenced by lower rates of skipping classes), the lower the level of reported school bullying.

Student-level (Equation 2-1)

$$\text{Relational bullying}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socio-economic status}_{ij}) + \gamma_{ij}$$

School-level (Equation 2-2)

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \gamma_{04}(\text{School-level socio-economic status}_j) + \gamma_{05}(\text{Sense of shared belonging}_j) + \gamma_{06}(\text{Late for school}_j) + \gamma_{07}(\text{Skipping classes}_j) + \gamma_{08}(\text{Truancy}_j) + U_{0j}; \beta_{1j} = \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30}$$

The Relationship between School Administrative Measures and Students' Core Competencies

Since the sense of shared belonging and attention to student attendance had a significant effect on relational bullying in Step 2, we tested the influence of these two school-level independent variables on students' core competencies during Step 3. Adopting Equations 3-1 and 3-2, the analytical results are as follows. First, in terms of mathematical competency, the coefficients for sense of shared belonging ($\gamma_{05} = 62.82, p < 0.01$) and skipping classes ($\gamma_{07} = -182.27, p < 0.01$) reached statistical significance. Second, for reading competency, the explanatory effect for skipping classes ($\gamma_{07} = -164.04, p < 0.01$) was significant, while the sense of shared belonging was related at a statistically insignificant level. Third, regarding science competency, both sense of shared belonging ($\gamma_{05} = 53.51, p = 0.02$) and skipping classes ($\gamma_{07} = -185.00, p < 0.01$) demonstrated statistically significant effects. The results of Step 3 imply that higher degrees of sense of shared belonging are associated with higher scores in terms of students' mathematics and science competencies. Furthermore, more attentive school administrative measures (by managing students' attendance and lowering the number of skipped classes) were associated with higher scores for all three core competencies.

Student-level (Equation 3-1)

$$\text{Core Competency}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socio-economic status}_{ij}) + \gamma_{ij}$$

School-level (Equation 3-2)

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \gamma_{04}(\text{School-level socio-economic status}_j) + \gamma_{05}(\text{Sense of shared belonging}_j) + \gamma_{07}(\text{Skipping classes}_j) + U_{0j}; \beta_{1j} = \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30}$$

The Indirect Effect of School Administrative Measures on Students' Core Competencies through the Mediator of School Bullying

After conducting Steps 1 through 3, the independent variables meeting the criteria for analysis by Step 4 of the multi-level mediation model were: a) sense of shared belonging and b) skipping classes, with a mediator of relational bullying. In terms of depend-

ent variables, because the sense of shared belonging and students' reading competency was not significantly related, we only tested the mediation effect from the sense of shared belonging on mathematics and science competencies while examining the mediation effect of skipping classes on all three core competencies.

First, regarding a sense of shared belonging, we used Equations 4-1 and 4-2, including the dependent variables of mathematics and science competencies, to obtain the coefficients for their influence without including the mediator of school bullying. Then, following Equations 4-3 and 4-4, the coefficients for the sense of shared belonging for mathematics and science competencies were computed while including school bullying as a mediator. The results demonstrated that the coefficient for the influence on mathematical competency changed from 90.85 to 87.59, and the coefficient for the influence on science competency changed from 82.06 to 79.76. Based on these findings, the influence of relational school bullying on mathematical ($\gamma_{50} = - 8.26, p < 0.01$) and science ($\gamma_{50} = - 5.81, p = 0.02$) competencies were significant. Given that when the variable of relational school bullying was included as a mediator, the coefficient for the influence of sense of shared belonging on the dependent variables was lower as compared to the model which did not include relational school bullying, we conclude that a mediation effect did exist. However, this mediation was only partial, since the coefficient for the sense of shared belonging (a school-level variable) was still significant.

Second, in terms of the effects of the school-level variable of skipping classes, we adopted the same procedure described above. Equations 4-5, 4-6, 4-7, and 4-8 were used to test the effects on mathematics, reading, and science competencies. The results demonstrated that when the variable of relational bullying was included, the coefficients for the influence of relational bullying on the three core competencies were all significant (mathematical competency: $- 8.30, p < 0.01$; reading competency: $- 5.38, p = 0.02$; science competency: $- 5.86, p = 0.02$), while the coefficients for the school-level variable of skipping classes changed from $- 210.34$ to $- 206.01$ for mathematics competency and from $- 184.86$ to $- 182.05$ for reading competency. Likewise, the coefficient for science competency changed from $- 208.91$ to $- 205.85$. Thus, after relational bullying was included, the coefficient for the influence of the school-level variable of skipping classes on the three core competencies was lower than the model that did not include the mediator of relational bullying. Since the coefficient of the context variable of skipping classes reached a significant level, relational bullying was concluded to provide partial mediation.

Student-level (Equation 4-1)

$$\text{Core Competency}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socio-economic status}_{ij}) + \gamma_{ij}$$

School-level (Equation 4-2)

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \\ &\gamma_{04}(\text{School-level socio-economic status}_j) + \gamma_{05}(\text{Sense of shared belonging}_j) + U_{0j}; \beta_1 \\ &= \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30} \end{aligned}$$

Student-level (Equation 4-3)

$$\text{Core Competency}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socio-economic status}_{ij}) + \beta_{5j}(\text{Relational bullying}_{ij}) + \gamma_{ij}$$

School-level (Equation 4-4)

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \\ &\gamma_{04}(\text{School-level socio-economic status}_j) + \gamma_{05}(\text{Sense of shared belonging}_j) + U_{0j}; \beta_{1j} \\ &= \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30}; \beta_{5j} = \gamma_{50} \end{aligned}$$

Student-level (Equation 4-5)

$$\text{Core Competency}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socio-economic status}_{ij}) + \gamma_{ij}$$

School-level (Equation 4-6)

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \\ &\gamma_{04}(\text{School-level socio-economic status}_j) + \gamma_{05}(\text{Sense of shared belonging}_j) + \\ &\gamma_{07}(\text{Skipping classes}_j) + U_{0j}; \beta_{1j} = \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30} \end{aligned}$$

Student-level (Equation 4-7)

$$\text{Core Competency}_{ij} = \beta_{0j} + \beta_{1j}(\text{Gender}_{ij}) + \beta_{2j}(\text{Grade}_{ij}) + \beta_{3j}(\text{Socio-economic status}_{ij}) + \beta_{5j}(\text{Relational bullying}_{ij}) + \gamma_{ij}$$

School-level (Equation 4-8)

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \gamma_{01}(\text{School type}_j) + \gamma_{02}(\text{School size}_j) + \gamma_{03}(\text{School location}_j) + \\ &\gamma_{04}(\text{School-level socio-economic status}_j) + \gamma_{05}(\text{Sense of shared belonging}_j) + \\ &\gamma_{07}(\text{Skipping classes}_j) + U_{0j}; \beta_{1j} = \gamma_{10}; \beta_{2j} = \gamma_{20}; \beta_{3j} = \gamma_{30}; \beta_{5j} = \gamma_{50} \end{aligned}$$

Discussion

Based on the findings of previous single-level studies, our research expanded upon this framework in developing a multi-level mediation model using the 2015 PISA data from mainland China. The results demonstrate that two independent variables played indirect and positive roles in terms of influencing students' core competencies by reducing school bullying. These two independent variables are a sense of shared belonging (which had a positive effect on students' competencies) and skipping classes (which when lowered, is associated with better outcomes in terms of students' competencies). These school-level variables reflect schools' administrative efforts to develop a positive environment for teaching and learning (reflected in the aggregate score of students' sense of shared belonging) and the schools' attentive administrative efforts, wherein monitoring of students' attendance was consistently adopted, as reflected by students' attendance (with more attentive administrations deterring students from skipping class

mitigating the relationship between skipping classes and experiencing bullying, as well as reducing the negative relationship between skipping classes and students' core competencies). Since these two independent variables are deemed to be highly practical and directly applicable to the field of educational management, the findings of this study provide a reference for school administrators to prevent and control school bullying and simultaneously improve students' core competencies. In light of the impact of students being late for school or truant, which are in violation of school rules and may indicate the presence of school bullying, and the resulting impacts on students' core competencies, according to this study, school management should focus more closely on students' attendance, particularly in terms of skipping classes.

Application of Multi-level Mediation Model

This study adopted a multi-level mediation model, which is rare in research regarding both school bullying and students' core competencies. In contrast, most studies use regression analysis including multiple predictor variables in the model simultaneously. However, a multi-level mediation model is a more appropriate method for further elaborating on the specific paths of influence among factors that, in turn, can provide more specific feedback and recommendations for educational administrators. Studies adopting regression analysis on school bullying among adolescents in Guangdong Province (Wang et al., 2012), Ontario, Canada (Betts, 2014), and Quebec, Canada (Di Stasio, Savage, & Burgos, 2016) have been conducted, but with mixed or unclear results. Likewise, Zhao et al. (2017) and Huang (2017), in analyzing science competency and school bullying among students from four provinces of China, also adopted the 2015 PISA data. However, although these studies found several significant explanatory variables at different levels, in terms of core competencies or school bullying, they were unable to further specify paths of influence for the factors included in their models, due to their use of multiple regression.

Thus, our multi-level mediation model aims to evaluate the factors that have demonstrated significant explanatory power in the past, and further evaluating paths among variables and their relative influence, which has potential theoretical contributions for the related research topics. At present, only Wang and Meng (2017) have published research using a multi-level mediation model, finding that the school atmosphere directly influences a number of student-level variables, which then has an indirect positive role in science competency. With the application of multilevel analysis in educational research becoming more and more popular, we expect that multilevel mediation model applications will be developed more extensively in the future.

Attentive Measures for Preventing School Bullying

The results of this study demonstrate, in terms of school administration, that it is beneficial for schools to enact measures that combine attentive approaches to the enforcement of school rules (in particular, students' attendance) as well as measures that can develop a sense of shared belonging. Building students' sense of shared belonging and

paying greater attention to students' attendance can reduce the occurrence of relational bullying among students, resulting in an indirect positive impact on their performance, in terms of core competencies. These two types of administrative approaches can jointly contribute to the development of a safe and positive learning environment for students. In this learning atmosphere, bullying can be reduced and, as a result, students may experience greater feelings of acceptance, resulting in greater willingness to seek help from others, even if they are bullying by their peers and avoidance of subsequent bullying. At the same time, when school administrators and teachers are focused on monitoring students' attendance, they can identify students who may be suffering from school bullying (which may be the underlying cause of student lateness, skipping classes, or truancy), which is conducive to immediate interventions. The results of this study echo the recommendations of PISA's school bullying report (OECD, 2017a) which calls on schools to create environments where students feel closer connections with teachers and clearly recognize that the school is an orderly place wherein school rules are followed. This recommendation is highlighted by the findings of this study that suggest school administration efforts can make students feel at ease and can prevent bullying events.

Limitations

The paths constructed by our multi-level mediation model can provide empirical evidence that school bullying serves as a mediator between the school administrative measures and students' core competencies. However, it is still unclear whether or not there are other mechanisms influencing the relationships among the variables evaluated in this study. Since some factors are beyond the scope of this study and are not addressed in this manuscript, we suggest this lack of data as a limitation and potential for future analysis. For example, if a school adopts a more attentive model of student attendance management, this approach might first influence the overall sense of shared belongingness which, in turn, can decrease bullying and its influence on students' core competencies. As such, future studies can evaluate multiple paths of mediation. Next, since this study was based on a multi-level mediation model, we were required to follow corresponding steps for data analysis. During this process, although we found other interesting findings not directly related to the primary focus of this study there were not described in more detail in this manuscript. For example, the results of the first step of our multi-level mediation model demonstrated no significant correlations between verbal and physical bullying and students' core competencies; therefore, these two types of school bullying were not included in follow-up analyses, and their impact in terms of school management measures was not tested further. Finally, the data used in this study was limited to data reported in the 2015 PISA survey, which limits the explanatory power of some research results. For example, it is impossible to conclude why a sense of shared belonging at the school-level did not affect students' reading competency but had a positive effect on mathematics and science competencies. Since this issue cannot be explained by existing 2015 PISA data, further data collection and analysis are recommended.

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