

Research Article

How School Climate Affects Student Performance: A Fuzzy Set Qualitative Comparative Analysis Based on the Perspective of Education System

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Received 26 May 2022; Revised 9 October 2022; Accepted 27 October 2022; Published 7 November 2022

Academic Editor: O. S. Albahri

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School climate's dynamic effect on student is widely explored in the study in different subjects; however, quietly, a few types of research concentrate on comparing different dimensions of school climate's effect on student and the influence path in different countries. To analyze and compare the school climate's mechanism in different countries' basic education system, this article used a comparative method to explore the explanation of school climate on school students' performance. With the application of 73 countries' panel data from the PISA database, the author calculated the different school climate combinations' consistency and coverage in relation to school students' performance by fs-QCA. The author found that the punctuality of students and the classroom discipline can explain the good performance of students. It also found that the combination of multidimensional school climate has a higher explanatory power than a single factor. Finally, this study ends with countermeasures and suggestions which include improving the school climate of the regional education system and improving the utility of school climate through the appropriate mix of school climate.

1. Introduction

With science and technology leading the development of educational technology and the popularization of education for all, many developed countries aimed to improve the performance of basic education students by increasing educational investment, improving the level of teachers, and improving campus facilities. However, since the beginning of the 21st century, countries with high investment in basic education have frequently encountered problems such as a decline in student's performance, education inequity, and student's mental problem. These phenomena lead scholars to trace the causes of environmental factors and cause a deeper discussion of school climate. Therefore, in recent years, the school climate of elementary schools is gradually being valued by researchers and educators which are regarded as

an important factor influencing the performance of students. The assessment and improvement of school climate become an imperative reform focus while quantitative research on school climate has also become a necessary method to guide basic education promotion strategies.

The research methods and paradigms of school climate have undergone great changes in the past 30 years. To clarify the connotation of school climate and conduct comparative research between different regions, scholars reconstructed the school climate research system in the regional education system through quantitative research. The main approach is to construct a dynamic measurement system of school climate and to study the regular relationship between school climate and the performance of students. By collecting data through multiple channels and establishing empirical research models, many scholars have proved the hypothesis

that a good school climate can promote the development of students, especially the students in primary and middle school [1, 2]. Despite this, the existing research on school climate's effect on student's academics still remains some gaps to close. Firstly, the previous research focuses on exploring this topic on the national or regional scope, and quietly, a few scholars try to compare the effects in different education systems which would limit the subject to a relatively microscopic level. Secondly, many research papers have not taken all dimensions of school climate into consideration in the empirical study; moreover, the endogenous relationship between different school climates is also neglected by most research. The research gap calls for concentration on the multiple dimensions and dynamics scope of school climate and the specific environment of different education systems.

Because the school climate is a soft environment embedded in the education system, it has multiple dimensions, dynamic, and multiple targets. Therefore, research on school climate is under shifting from a static perspective to a systematic perspective. In case of the large heterogeneity in the economic and social development, science and technology, historical and cultural traditions, and institutional environment of different countries and regions, these elements have evolved to form the heterogeneity of the regional school climate which gives meaning to further comparative education study of school climate. How do different dimensions of school climate influence each other? Is there a specific mechanism for the influence of school climate on the performance of students? Is there a combination of school climates that enhances the performance of students? Solving the above three research questions can make up for the limitations of the current quantitative research on school climate and provide a basis for the improvement of the school climate index system. On the other hand, it can provide targeted countermeasures and suggestions for shaping the school climate and giving full play to the efficiency of the school climate. In this way, the author of this article will clarify the connotative concepts and dimensions of school climate and combine the existing school climate research and the concept of the national education system to construct a quantitative analysis model that explores the impact of school climate on student performance at school. Moreover, this article uses different countries as research case to explore the impact of multidimensional school climate on the performance of students.

2. Literature Review

2.1. The Framework and Dimensions of School Climate. School climate is essentially an environmental element. The National School Climate Council recommends that school climate is based on patterns of people's experiences of school life and reflects norms, goals, values, interpersonal relationships, teaching and learning practices, and organizational structures. A sustainable, positive school climate could foresters youth development and learning necessary for a productive, contributive, and satisfying life in a democratic society [3]. School climate is a perceived

atmosphere that has different effects on different types of participants.

The school climate is multidimensional and has regional and cultural characteristics. Therefore, the school climate index systems constructed by different countries, regions, and international organizations are also different. Nevertheless, because school climate is an environmental element, it mainly includes four broader aspects: order and safety, social relations, teaching and learning environment, and systems and facilities [7]. The further classification is different, and Table 1 indicates different subdivisions of school climate which includes the dimensions from authoritative international organizations, dimensions from local organizations (such as the Ministry of Education and local government organizations), and the dimensions from international influential literature. Through comparison and summary, it can be found that although the subdivision dimensions of school climate are roughly similar, they are not uniform, and the indicators developed by some national institutions and scholars more reflect the local culture, local campus problems, and regional characteristics. In addition, the subdivision of school climate is also closely related to the perceivers of school climate. Schools at different stages and different participants in the schools are the basis for further subdivision of the school climate index system.

2.2. School Climate's Effect on Student's Performance. In the empirical research, the mechanism of school climate on the performance of students can be roughly divided into two types. One is that a positive school climate can promote desirable factors of students, and the other is to reduce the undesirable factor of the students in school. Since students' performance also has multidimensional evaluation standards, the academic achievements of school climate researchers also have their own emphasis. This article will classify and discuss the impact of different dimensions of school students' performance affected by school climate.

For students, achievement plays a decisive role which is an important reflection of regional and national educational efficiency. Achievement as an educational output can be roughly measured by academic performance and scientific research results [10]. Among them, scientific research achievement indicators are mainly applicable to higher education students while academic performance has wider applicability and scientific, especially the popularization of international education databases increase the comparability of student performance in each nation. Students' participation in the school, sense of security, sense of belonging, perceived teacher enthusiasm, classroom discipline and order, etc., have been repeatedly shown to positively affect students' academic performance [11–14]. In addition, parental involvement is also considered to constitute a positive school climate that positively affects student performance [15, 16]. In general, the influence of school climate on the academic performance of students is the mainstream of school climate research which is also the most concerned issue of education researchers, education policymakers, and education implementers in various countries.

TABLE 1: Dimensional division of school climate.

Organization	Dimensions of school climate
PISA2018	Student destructive behavior and safety; teaching and learning environment; engagement and belonging; institution environment
NSCC [3]	Body safety; norm; emotional safety; learning support; respect for difference; surroundings; social media; relationships
US Department of Education 2020	Student engagement; health; surroundings
US National Center for Education Statistics (NCES)	School environment; safety and security; safety and equity; disorder behavior
California Healthy Kid Survey (CHKS) [4]	Engagement and support; safety; mental health
Virginia School Climate Survey [5]	Perception of discipline and regulation; teacher-student relationships; engagement; bullying culture
Wang and Degol [6]	Safety and order, learning environment, connections; facilities
Daily et al. [8]	Teacher-student relationship; safety and order; student engagement; academic support; sense of belonging
Riekie et al. [9]	Communication equity; teacher's support; respect of difference; regulation and discipline; initiative

Another mainstream direction of school climate research is the impact on the healthy development of students which includes physical health and mental health. In terms of physical health, Kathryn et al. [17] found that the BMI (body mass index) of students will drop significantly alone with the improvement of school climate. Gase et al.'s empirical research based on middle school students in Los Angeles confirms that a good school climate can reduce the frequency of exposure to tobacco and alcohol by middle school students, thereby improving the health of middle school students [18]. In terms of the impact on mental health, Lisa et al. [19] proved that a good school climate can significantly alleviate high-school students' pressure. Through empirical research on Australian middle school students, Riekie et al. [9] proved that a healthy school climate can positively affect students' well-being, resilience, and moral identity. In addition, a healthy school climate has also been proven to reduce student misbehavior, including classroom misbehavior [20], number of school violations [21], and negative attitudes [22].

In recent years, as school crime, violence, bullying, and other incidents have received considerable attention from scholars, many studies have begun to pay attention to the internal relationship between school climate and dangerous behaviors on campus. Through combing the relevant literature, the author found that the mechanism of school climate in such schools is still positive, in which students perceive a good school climate can help them resist school violence [23, 24], reduce self-abuse and suicidal tendency, and alleviate the impact of school violence on student performance [25]. Moreover, school climate can not only directly reduce the phenomenon of campus bullying and violence but also can be used as a moderating variable to alleviate the adverse effects of campus bullying on student development. Student attendance is another manifestation of student performance, and it is also one of the manifestations of students' healthy development. Researchers tend to reflect the influence of school climate on student attendance through both positive and negative aspects: On the one hand, a good school climate can increase the attendance

rate [26]; on the other hand, it can avoid the emergence of lateness, absenteeism, early dropout, and other problems [27].

Finally, in addition to the above specific student performance and behavior, scholars in recent years have begun to pay attention to the impact of school climate on students' learning styles and innovative thinking. Among them, a good school climate has been shown to positively affect students' learning willingness and motivation [28], and its mechanism is to increase student participation and positive feedback [29]. Moolman et al. [30] have proved through qualitative longitudinal research that a good school climate can bring a good peer education effect to secondary schools, thereby promoting students to learn in a more active way. Lastly, the school climate can cultivate the innovative thinking of the students at school, and the main mechanism is to shape a proactive personality and the pursuit of success as well as reduce students' fear of failure [31]. The main trend of current school climate research is the breakdown of casual and result variables. However, few studies have paid attention to the interaction between different dimensions of school climate and its effect on student performance. The previous research concerning about school climate's effect on student in the last 5 years become quite abroad while there remain some drawbacks. Firstly, the previous research applied the regular research method which only focus limited dimension of school climate's effect on student. Secondly, most existing research ignores the interactive relationship between different dimensions of school climate in the process of empirical study. Thirdly, the previous research method mostly relies on the regression to explore the linear relationship and is seldom based on the systematical perspective. Table 2 summarizes the research on school climate's influence on students.

2.3. *National Educational System.* Education system theory is a concept in pedagogical management. It can start by treating schools, regions, and countries as an education system and taking the standards of student development, enhancement of competitiveness, and increase of added

TABLE 2: Research of school climate's influence on students.

Outcome variable	School climate dimensions	Research gap
Academic outcome	Relationship; teacher's support; discipline	The interaction with other factors is ignored (such as family)
Body health	Engagement; parental involvement	Some potential control variables are missing
Mental health	Belonging; discipline; leadership	Too rely on the student's self-report
Attendance	Student cooperation; belonging; relationship; teacher's support	The measurement of student absent is too single
School bullying	School management; safety; discipline	Lacking cross-national comparison
Learning style and innovative	Teacher's devotion; professional development	Lacking cultural background

value as motives. Regarding decision-makers, students, teachers, related organizations, service organizations as the resources and elements in the system, education system explores the optimization plan of resource allocation through dynamic and balanced research methods [32]. Compared with static equilibrium research, system research pays more attention to the coupling effect between various elements. In addition, the education system theory inherits the attention to the dynamics of the internal and external dynamic environment of the system in other theoretical topics, and the school atmosphere has therefore become an environmental variable that affects various elements in the education system research. The educational system provides a new research paradigm for educational research. Vegas and Coffin [33] use the national education system as a research perspective to explore the relationship between the basic education expenditures of all countries participating in the PISA survey and the performance of school students and further discuss other factors that affect the efficiency of a country's education [33]. Wikan and Bugge [34] take the Norwegian teacher education system as a research perspective and explore the set of factors that affect the quality of teacher education through the student elements, institutional elements, management elements, and structural elements in the system.

In this way, the education system can be applied as a scope to explore the influence of various elements and the internal and external environment of the system in the macro, micro, physical, and virtual education process at the same time. This paper takes the education system as a research perspective, the school climate as the dynamic environment within the education system, the school students as the research object, and student performance indicators as output variables. The impact of gaining a school atmosphere can significantly promote the development of students in the education system.

3. Methodology

3.1. Research Method. In previous studies on the impact of school climate on the performance of school students, quantitative analysis using panel data could not include all dimensions of school climate in the research category at the same time. Although qualitative analysis can better explore the interaction of elements in regional innovation, the research results often cannot represent general laws. The

application of mixed research methods is an effective way to solve the above problems. Qualitative comparative analysis (QCA) can conduct a causality test to explore the explanatory power of multidimensional school climate on school students' performance. Qualitative comparative analysis uses the concept of the set to combine multiple factors to find the greatest explanatory power for the results. The qualitative comparative analysis method improves the limitations of traditional statistics for single-factor analysis through systematic case quantification and comparison [35]. Regin developed a fuzzy set qualitative comparative analysis method (Fs-QCA) to narrow the range of variables between 0 and 1. At the same time, researchers can define any value between 0 and 1 as a qualitative "high" or "low" threshold according to the characteristics of the case. Fs-QCA is suitable for analyzing small- and medium-scale data samples and has certain practicability in the field of social sciences. Typical studies of this method include the analysis of the elements that affect the effectiveness of the resistance in the struggle of community residents [36], the study of companies or national high-tech industries [37], and the impact of regional characteristics on the performance of innovation systems [38]. In the Fs-QCA research, the comparative research results of multiple cases are displayed through two important variables: the first is the consistency variable, and its expression is as follows:

$$\text{Consistency}(X_i \leq Y_i) = \frac{\sum[\min(X_i Y_i)]}{\sum X_i} \quad (1)$$

A consistency value greater than 0.8 means that more than 80% of the cases meet the consistency condition, and X can be considered a sufficient condition for Y . In addition, another result variable is Coverage, whose expression is as follows:

$$\text{Coverage}(X_i \leq Y_i) = \frac{\sum[\min(X_i Y_i)]}{\sum Y_i} \quad (2)$$

The coverage index can show the breadth of the results caused by each set of reasons, and the high coverage can be supported by a higher proportion of cases. It is worth noting that the coverage rate does not prove that the causal variable is a sufficient condition.

The author takes the national basic education system as the research unit. Therefore, student performance is the outcome variable of the education system, and different dimensions of school climate are the causal variable. This

TABLE 3: Overview of school climate dimensions and questionnaire.

School climate	Question number	Specific question in questionnaire
Degree of effort (effort)	ST036	Studying hard in school is important to me
		Studying hard at school can help me find a good job
		Studying hard in school can get me into a good University
Degree of competition (comp)	ST205	The students at the school seem to value competition
		The students in the school are in fierce competition
		The school is passing on the idea that competition is important
		Students at the school think they are being compared with other classmates
Degree of cooperation (coop)	ST206	The students at the school seem to value cooperation
		Students in the school often cooperate with each other
		The students at the school are passing on the idea that cooperation is important
		The students in the school feel that they are being encouraged to participate in cooperation
Sense of belonging (bel)	ST034	I can easily make friends at school
		I feel a sense of belonging at school
		Friends around me at school seem to like me
Discipline and rules (discip)	ST097	In school class, students do not like to listen to the teacher
		Noisy and disorderly classrooms in school
		It takes a long time for teachers in school class to wait for students to calm down
Teacher's enthu (enthu)	ST213	I know very well that the teachers in the class like to teach us
		Teachers enjoy the joy of teaching in the classroom
Punctuality (punc)	ST062	I was absent from school for one day in the last two weeks
		I have missed a few classes in the last two weeks
		I have been late in the last two weeks

Data source: PISA2018 student questionnaire.

method explores the combination of school climate that has a high degree of explanation for the performance of school students as well as classify and discuss typical countries.

3.2. *Research Data.* This article selects the school climate data from the PISA student questionnaire as the data source. This questionnaire contains more than 600,000 15-year-old middle school students in 73 countries and regions about the school climate which is widely used by domestic and foreign scholars in the research of school climate. In addition, the PISA database can perform data analysis from three perspectives: country, school, and individual. The study uses countries and regions as analysis cases and uses the seven dimensions of school climate in the questionnaire as causal variables. Table 3 shows the school climate dimensions in the PISA report and their corresponding questionnaire questions.

Table 4 shows the descriptive statistics of various types of school climate. The school climate is quite heterogeneous in different countries. In general, the highly rated school climate in various countries is classroom discipline and teacher enthusiasm while the relatively low evaluated is the degree of competition and the sense of belonging of the students in the school. To comply with the Fs-QCA operating specifications, the study standardized the school climate data of various countries and the value of the scale data to the [0, 1] interval. As the result variable, the performance of students is also a multidimensional variable. Combined with previous studies, this article chooses students' academic performance as the main variable to measure the performance of students at school. Lastly, the author

sets the threshold value as 0.8 which indicates that the consistency beyond 0.8 represents a high explanatory of school climates combinations on student's performance.

4. Result and Discussion

This article uses the three average scores (reading, mathematics, and science) in the PISA test scores as a measure of the impact of school climate in the education system on the performance of school students. Table 5 shows the impact of a single school climate dimension on school students' performance. Each school climate dimension's consistency is lower than 0.8 which indicates that single dimension of school climate could not explain student performance in national education system. Therefore, it is necessary for the research to further explore the degree of explanation of the school climate combination for the performance.

According to the mechanism of Fs-QCA, the author outputs the truth table which is based on the preliminary consistency and coverage statistics of all kinds of school climate. Since this study has 7 school climate dimensions, the education systems of various countries can be distributed in 128 different school climate combinations. Table 6 shows the school climate combinations with a consistency higher than 0.7 in the truth table. The author finds that there is indeed a specific combination of school climate that can explain the better performance of students. One group of combinations has a consistency higher than 0.8, and 10 groups have a consistency of higher than 0.7. This result accounts for approximately 8.6% of all combined categories and the

TABLE 4: Descriptive analysis of school climate.

School climate	Case	Min	Max	Mean	Std
Effort	73	2.02	2.64	2.314	0.143
Competition	73	2.18	2.99	2.556	0.187
Cooperation	73	2.32	3.14	2.686	0.166
Belonging	73	1.63	2.86	1.908	0.184
Discipline	73	2.63	3.56	3.001	0.197
Enthusiastic	73	2.64	3.38	2.902	0.158
Punctuality	73	2.04	2.92	2.460	0.207

TABLE 5: Single casual factor impact analysis.

Casual factor	Consistency	Coverage
Effort	0.677	0.76
~Effort	0.653	0.776
Competition	0.665	0.777
~Competition	0.678	0.774
Cooperation	0.696	0.784
~Cooperation	0.662	0.783
Belonging	0.703	0.772
~Belonging	0.672	0.812
Discipline	0.606	0.812
~Discipline	0.786	0.665
Enthusiastic	0.608	0.675
~Enthusiastic	0.794	0.813
Punctuality	0.792	0.904
~Punctuality	0.654	0.665

“~” denotes the absence of the following factor in Fs-QCA.

TABLE 6: The truth table analysis.

Effort	Comp	Bel	Coop	Discip	Punc	Enthu	Case	Consistency
0	1	0	1	0	1	0	4	0.845
0	0	0	0	0	1	0	2	0.795
0	0	1	0	0	1	0	1	0.784
1	0	1	1	0	1	0	3	0.783
1	1	0	0	0	1	0	1	0.767
1	0	0	1	0	1	0	1	0.753
0	0	0	0	1	1	0	1	0.748
1	0	1	0	0	1	0	2	0.746
0	1	1	1	0	1	0	1	0.722
1	0	0	1	1	1	0	1	0.709
1	1	0	0	0	1	1	5	0.700

countries represented by these combinations covered account for 28.9% of the total sample countries. Moreover, this study finds that the overall punctuality of students can explain the good performance of the students in school while the enthusiasm of the teachers and the discipline of the classroom lack explanatory power.

To further subdivide the research results and obtain more regular results, the author uses the path solution function in Fs-QCA to explore the interpretation plan for outstanding school students’ performance. There are four school climate combinations that show high interpretive ability for the performance of students which is indicated in Table 7. As to the contribution to the students’ performance of different combinations of school climate, the author finds punctuality is the most important determinant in student academic performance. In addition, other dimensions of school climates’ effects are

different which would depend on the ways of coexisting and evolving in different countries’ specific situations.

To explore the impact of school climate on the performance of students in school more comprehensively, the study further explored the role of school climate in reducing negative effects in the education system. The author sets the PISA’s evaluation of school bullying as the student’s performance and conducted the single factor impact analysis and path solution by Fs-QCA. The results showed that no single factor can determine the student’s bullying without regard for other factors which is the same as the result of student academic performance. As to the path solution analysis in Table 8, there are three combinations of school climates that could explain the resistance and low outbreak rate of bullying, and the common features are the punctuality as well as the absence of classroom discipline.

TABLE 7: Solution path of school climate combinations on student grade.

Number	Consistency/Coverage	Combinations	Case
1	0.961/0.391	Effort * ~comp * coop * bel * enthu * punc	Japan, Finland
2	0.959/0.358	~Effort * comp * coop * ~bel * ~enthu * punc	Hong Kong, Marco
3	0.940/0.404	Effort * comp * ~coop * ~bel * ~discip * punc	US, UK, Ireland, New Zealand
4	0.923/0.927	Effort * comp * coop * ~bel * discip * enthus * punc	China (B-S-J-Z), Korea, Singapore

TABLE 8: Solution path of school climate combinations on student bullying.

Number	Consistency/Coverage	Combinations	Case
1	0.951/0.385	Effort * ~comp * bel * ~discip * ~enthu * punc	Netherlands, Finland, Iceland, Germany
2	0.938/0.406	~Effort * comp * bel * ~discip * ~enthu * punc	Switzerland, Norway
3	0.339/0.951	Effort * comp * ~coop * ~bel * ~discipline * enthu * punc	Sweden

Compared with the previous research which applied factor-factor linear relationship analysis, this paper has some different findings. Firstly, despite the specific dimension of school climate taking effect on the student, the dimensions would affect each other, those interactions include the mediating effect, moderating effect as well as compensation effect, and those effects are always ignored by previous research. Secondly, even if the specific school climate portfolio would lead to a high-performance regional education system’s performance, there also exist some low-educational performance countries which have the same school climate combinations as the high-educational performance countries. Under these circumstances, the author finds the economy and culture also play important roles in education systems. Lastly, school climate in the education system is hard to shape and change; in this way, the policymakers should concentrate on improving the utility of different dimensions of school climate rather than adapting them.

5. Conclusion

This article uses an Fs-QCA to explore the influence of school climate on school students’ performance based on the perspective of the national basic education system. Taking basic education students’ academic performance and bullying avoidance as variables to measure the performance of students, the study found several combinations of school climate that led to better student performance and proved that punctuality and discipline are more important school climates. This article is not only the first attempt to explore the performance of school climate on students based on the perspective of the education system but also a preliminary exploration of the Fs-QCA in the field of comparative education. The results would change the research orientation of school climate’s effect to a systematical and dynamic scope and focus on the interaction between different dimensions of school climate and cultural, social, and technological development’s mediating effect. This article still has two unresolved defects: first of all, the factors that affect student performance from the perspective of the education system should not be limited to environmental factors such as school climate but should also include elements such as basic education public expenditure, family investment, teacher

level, policy and management level, and these factors are explored in this article failure to be included in the assessment in the process of school ethos affecting the performance of students. Secondly, although this study has selected the mathematics, reading, and science scores assessed by the PISA, and the evaluation of bullying as the measurement variables of school students’ performance, the current global database on the physical and mental development of basic education students is not yet complete. Therefore, the result variables of the Fs-QCA still need to be further supplemented. The school climate has a profound impact on all participants on the campus. There are two main directions for the future development of this research: the first one is to explore the school climate’s effect on the other participants at the campus; the other one is to explore the dynamics ability of students, such as the critical thinking as well as intracultural competence.

Data Availability

The data of this paper are from the PISA2018 student questionnaire, which is available at <https://www.oecd.org/pisa/data/2018database/>.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Shandong Social Science Planning Project: The Research on the Measure and Different Paths of Green Development among the Central Cities in the Lower Reaches of the Yellow River (21DJJJ06).

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