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WHICH IS MORE RELATED TO LITERACY SKILLS, COMPETITION OR COOPERATION? EVIDENCE FROM PISA 2018 RESULTS

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Abstract

Although previous research has demonstrated that school climate (leading to a climate of competition or cooperation) is related to student achievement, including their literacy skills, there is still insufficient evidence which of the two school climates is more related to literacy skills. Therefore, this study examined the relationship between the two sets of variables in the PISA 2018 Results data: students' perceptions of school climate (PERSCHL) and literacy skills (LITERACY). The PERSCHL set consists of perceptions of the level of competition (PERSCOMP) and cooperation (PERSCOOP) in schools, while LITERACY set consists of mathematical literacy (MATH), reading (READ), and science (SCIE). The level of perception in the PERSCHL set was estimated using the Graded Response Model (GRM), while literacy skills was calculated from the average of 10 Plausible Value (PV) that has been available in the data of PISA 2018 Results. The research hypothesis was tested using canonical correlation analysis. The results of the data analysis showed that the positive students' perceptions of competitive and cooperative school climate had a positive and significant association with literacy skills although with a small correlation index. Second, perceptions of competition have a higher relationship with literacy skills than perceptions of cooperation in schools but the difference between the two is small. Both competition and cooperation in schools still need to be developed to facilitate the improvement of student literacy skills individually and collectively.

Keywords: Canonical correlations; competition; cooperation; literacy skills; school climate.

Abstrak

Meskipun penelitian terdahulu telah menunjukkan bahwa iklim sekolah (mengarah pada iklim kompetisi atau kooperasi) berkaitan dengan prestasi siswa, termasuk keterampilan literasi mereka, masih belum cukup bukti mana di antara kedua iklim sekolah tersebut yang lebih berkaitan dengan keterampilan literasi. Oleh karena itu, penelitian ini mengevaluasi hubungan antara dua himpunan variabel pada data PISA 2018 Results, yaitu persepsi siswa terhadap iklim sekolah (PERSCHL) dan kemampuan literasi (LITERACY). Himpunan data PERSCHL terdiri atas persepsi terhadap tingkat kompetisi (PERSCOMP) dan kooperasi (PERSCOOP) di sekolah, sedangkan himpunan data LITERACY terdiri atas literasi matematis (MATH), membaca (READ), dan sains (SCIE). Tingkat persepsi pada PERSCHL diestimasi dengan Graded Response Model (GRM), sedangkan kemampuan literasi dihitung dari rata-rata 10 Plausible Value (PV) yang ada pada data hasil PISA 2018. Hipotesis penelitian diuji dengan analisis korelasi kanonis. Hasil analisis data menunjukkan bahwa persepsi positif siswa terhadap iklim sekolah yang bersifat kompetitif dan kooperatif berhubungan positif dan signifikan terhadap kemampuan literasi meskipun indeks korelasinya kecil. Selain itu, persepsi pada kompetisi memiliki hubungan yang lebih kuat dengan kemampuan literasi dibandingkan persepsi pada kooperasi meskipun perbedaan di antara keduanya kecil. Kompetisi dan kooperasi di sekolah keduanya masih perlu untuk dikembangkan untuk memfasilitasi pengembangan kemampuan literasi siswa, baik secara individu maupun kolektif.

***Kata kunci**: Iklim sekolah; kemampuan literasi; kompetisi; kooperasi; korelasi kanonis.*

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INTRODUCTION

School climate is one of the aspects that researchers focus on in the education field. Until the last decade, researchers still published the results of their research on the relationship between school climate and student performance (e.g., Berkowitz et al., 2017; Daily et al., 2019; Darling-Hammond & Cook-Harvey, 2018; Wang & Degol, 2016). School climate measurements are carried out with a variety of viewpoints, for example focusing on the safety and support power of the school environment (see Bradshaw et al., 2014), opportunities for students to learn, teacher and student relationships, and parental involvement (see Daily et al., 2019). These studies have shed light on the relationship between different school climates and student performance, such as literacy. However, the results of the aforementioned research, cannot be generalized in a wider scope, because the sample used is limited to one specific region or country

Literacy skills is one of the main focuses in the 21st century education in addition to several other skills, such as critical thinking, creativity, and collaboration (P21, 2015). In the past two decades, many researchers have focused on these 21st-century skills issues (e.g., Alismail & McGuire, 2015; Djidu et al., 2021; Jailani et al., 2020; Ozkale & Erdogan, 2020; Retnawati & Wulandari, 2019). Due to the importance of literacy skills, Organization of Economic Cooperation and Development (OECD) has organized the literacy skills assessment for more than two decades through the Programme for International Student Assessment (PISA).

Literacy skills are not just about the ability to read and write (Jailani et al., 2020). That is more about the ability to construct and validate knowledge (OECD, 2021). Literacy skills reflect the ability allowing a person to apply his knowledge and to identify, interpret and solve problems in various contexts in everyday life (OECD, 2019a). Literacy skills could also be defined as an ability to identify, understand, interpret, create, communicate, as well as compute using information from a variety of print, written, and digital media related to a variety of contexts.

The PISA measured literacy skills from three essential literacy domains including mathematics, science, and reading. The three literacy domains were also the focus of the present research in addition to other variables, namely students' perceptions of the school climate. Hitherto, researchers have not found an international consensus on the definition or dimensions of the school climate. But in general, the school climate reflects the quality and character of school life (Olsen et al., 2018). School climate is typically measured based on the perceptions of students, teachers, staff, and parents in the context of the classroom environment as well as the more general of school context (Olsen et al., 2018). Since there is no specific consensus on the dimensions of the school's climate, researchers need to emphasize what aspects or dimensions are measurement concerns in their research, rather than providing conclusions about the climate relationship between school climate and student performance.

While some researchers distinguish between school climate and school culture, they also explain that climate is a cultural component (Barkley et al., 2014). Barkley et al. (2014) stated that climate is seen as behavior, whereas culture consists of school norms. In this case, the school climate (i.e., the way people feel about their school) depends

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on the values and behavior of the people in the school (i.e., culture). Accordingly, the school climate is defined by the perceived beliefs of stakeholders about each school referring to the quality and character of school life, influenced by norms, goals, values, interpersonal relationships, learning practices, and organizational structures within the school (Smith et al., 2014).

A strong school climate can contribute not only to the improvement of schools from an academic perspective but also the overall quality within the school (Buckman et al., 2021). Efforts to improve school climate by principals and locals are not new, as school climate surveys are often used in education (Cornell & Huang, 2019). Among school initiatives and other achievement development strategies led by school leaders, the school climate, as a multifaceted construction, can serve as a catalyst to address the overall quality of the educational environment.

Research related to the school climate has been widely found in the literature. In general, there was a significant difference between the learning environment that indicated competition and cooperation (Cuadrado et al., 2017). Parris et al. (2018) found that the more positive students' perceptions of the school learning climate, the higher their academic achievement. However, the correlation between perceptions regarding school climate and students' academic achievements is not guaranteed to be always high. In other studies, there was a weak correlation but statistically significant between the two (Demirtas-Zorbaz et al., 2021). In other words, variables about the school climate cannot be underestimated due to their contribution to the development of students' academic abilities.

This current research intended to examine the relationship between two sets of variables: students' perception of school climate (PERSCHL) and literacy skills (LITERACY). This research focuses on two variables that are part of the school climate: the level of competition and the level of cooperation based on the perceptual response of students. Student perception of the study refers to the measurement of competition levels and school environment cooperation levels in the PISA 2018 Results. Two research questions guiding this research are as follows.

RQ1: Is there a relationship between students' perception of competition and cooperation with their literacy skills?

RQ2: Which of the PERSCHL variables is the most related to students' literacy skills?

METHODS

Research Design

This is a correlational research aimed to examine the relationship between a set of variables of student perception of school climate and a set of student literacy skill variables based on the PISA 2018 Results. School climate used the PISA 2018 was measured by students' perception of the learning environment in school based on two variables, namely competition and cooperation. Perception of competition in schools was measured by students' perception of the level of competition that occurs in the learning environment in school, both those that occur due to the behavior of fellow students, and those caused by conditioning formed by the school. The same way were also applied to the perception of cooperation.

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Population and Sample

Because the study is based on the PISA 2018 Results, the population of this study is all students who were targeted by PISA measurements, namely 15-year-old students who are a representation of 32 million students in 79 countries who participated in the PISA 2018. Furthermore, six hundred thousand students were participants in the PISA 2018.

Data Sources

The data used in this study was obtained from the data available in the PISA 2018 Results. The data used consists of two variable groups, namely students' perception of the school environment (PERSCHL) and student literacy skills (LITERACY). PERSCHL data is obtained from student responses on student questioners on the PISA studies (https://www.oecd.org/pisa/data/2018database/CY7_201710_QST_MS_STQ_NoNotes_final.pdf). The data of student perception about the school environment was taken on eight items of statements that represented two variables related to PERCHL, namely perceptions about the level of competition in schools (PERSCOMP) and perceptions about the level of cooperation in schools (PERSCOOP). Meanwhile, student literacy skill data is data on literacy skill test results consisting of mathematical literacy (MATH), science (SCIE), and reading (READ).

Data on student perception and literacy skills are available on student questioner data (can be accessed here: https://webfs.oecd.org/pisa2018/SPSS_STU_QQQ.zip). Student response data is taken in items related to the variables used in the study by examining the item code (see Table 1) on the student questionnaire. Measurement of PERSCOMP and PERSCOOP variables using the Likert scale (1 – 4). Therefore, the data obtained is in the form of response data encoded with the numbers 1 – 4 (1 = not at all true; 2 = slightly true; 3 = very true; and 4 = extremely true). Meanwhile, literacy skills data (MATH, READ, and SCIE) is taken from 10 Plausible Values (PV) which are the result of estimating student scores using the Item Response Theory (or IRT) approach and have been transformed (OECD, 2019a).

Before being used in the analysis process, we check the missing value of the data. After the examination, a missing value was obtained because the student did not respond to the item. Student response data containing missing values were excluded from the analysis process by deleting rows (raw deletion), namely deleting all incomplete participant responses (containing missing values). We did not impute the missing value but chose to delete the data with two considerations. Firstly, the missing value in the response data is random so deletion can be done (Pituch & Stevens, 2015). Second, this study does not aim to make comparisons between countries so that the deletion of rows in the data will not affect the conclusion of the analysis results. Therefore, the data is cleaned by issuing an observation that contains a missing value. Data cleaning was carried out on raw responses on all items used: PERSCOMP, PERSCOOP, SCIENCE, MATH, and READ. After data cleaning, 109305 of 600000 responses are left to be used in the canonical analysis process (see the Appendix).

Data Analysis

This study was conducted to evaluate the hypothesis regarding the presence or absence of a relationship between the set of variables regarding students' perceptions of the school climate (PERSCHL) and student literacy skills

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(LITERACY). The hypothesis used is H_0: $R_c = 0$ and H_a : $R_c \neq 0$, where R_c represents a canonical correlation coefficient that describes the relationship between two sets of analyzed variables, i.e., PERSCHL and LITERACY. In order to evaluate the hypothesis, canonical correlation analysis involving five variables. Of the five variables, two variables (PERSCOMP and PERSCOOP) are defined as the PERSCHL variable set and three variables (MATH, READ, and SCIE) are defined as the LITERACY variable set (Figure 1). The analysis was performed using CCA packages on RStudio (R Core Team, 2022).

Considering that the PERSCOMP and PERSCOOP data obtained are still raw data on student responses to questionnaire items in the form of ordinal data (1 – 4), we first estimate the level of student perception by using the graded response model (GRM) using mirt packages so that the measurement scale used in the canonical correlation analysis becomes a ratio scale. Data analysis using RStudio produced data on student perception levels on a scale of –4 to 4 which were then transformed using the same transformation to calculate PV in the PISA study with an average setting is 500 and standard deviation is 100. More details of this transformation are explained in the PISA technical report (OECD, 2019b). The student literacy skills data that is already available in the form of PV is calculated on average for PV1 to PV10. After the results of perception estimation and average PV are obtained, the data are then combined so that data consisting of six types are obtained: student identity (ID), PERSCOMP, PERSCOOP, MATH, READ, and SCIE which are ready for canonical correlation analysis.

Table 1. Item code in PISA data related to PERCHL and LITERACY

Variable group	Variable	Item code and statement
Student perception of school climate (PERSCHL)	Perception of the level of competition in schools (PERSCOMP)	ST205Q01HA (Students seem to value of competition) ST205Q02HA (It seems that students are competing with each other) ST205Q03HA (Students seem to share the feeling that competing with each other is important) ST205Q04HA (Students feel that they are being compared with others)
	Perception of the level of cooperation in schools (PERSCOOP)	ST206Q01HA (Students seem to value cooperation) ST206Q02HA (It seems that students are cooperating with each other) ST206Q03HA (Students seem to share the feeling that cooperating with each other is important) ST206Q04HA (Students feel that they are encouraged to cooperate with others)
	Mathematical literacy (MATH)	PV1MATH; PV2MATH; PV3MATH; PV4MATH; PV5MATH; PV6MATH; PV7MATH; PV8MATH; PV9MATH; PV10MATH
Student literacy skills (LITERACY)	Reading literacy (READ)	PV1READ; PV2READ; PV3READ; PV4READ; PV5READ; PV6READ; PV7READ; PV8READ; PV9READ; PV10READ
	Science literacy (SCIE)	PV1SCIE; PV2SCIE; PV3SCIE; PV4SCIE; PV5SCIE; PV6SCIE; PV7SCIE; PV8SCIE; PV9SCIE; PV10SCIE

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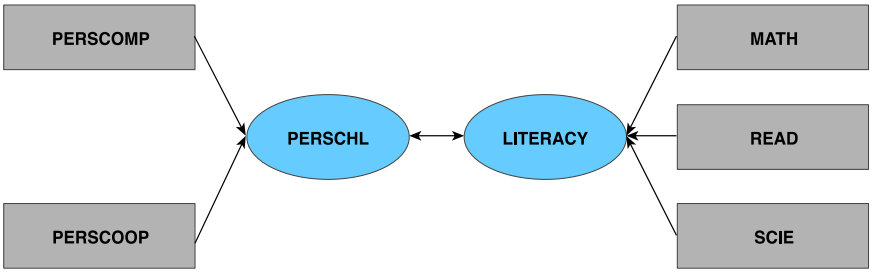


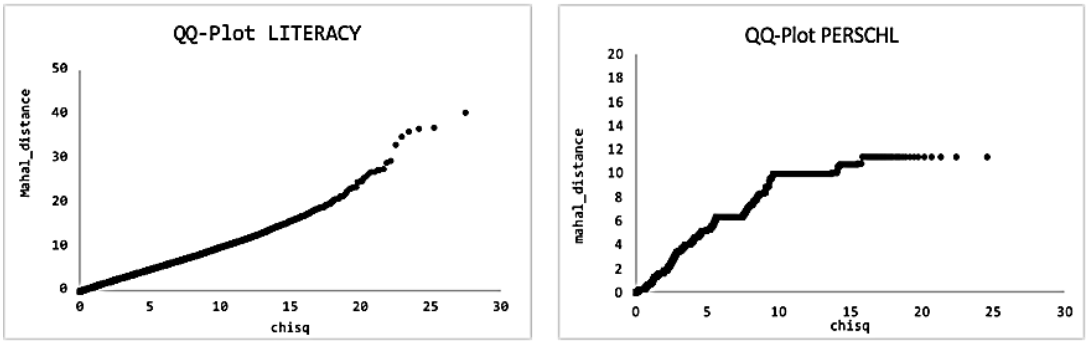
Figure 1. Associative model of PERSCHL and LITERACY

RESULTS AND DISCUSSION

Results

We first report the results of canonical correlation assumptions: homoscedasticity, multicollinearity, and multivariate normal distribution. Firstly, homoscedasticity was examined by using Spearman's rank correlation coefficient between canonical and residual variables and obtained Spearman's sig. (2-tailed) for PERSCOMP and PERSCOOP variables > 0.05 (0.59 and 0.19, respectively), so it was concluded that heteroscedasticity did not occur. In other words, assumptions of homoscedasticity were met.

Secondly, the results of the multicollinearity analysis show that all variables have a variance inflation factor (or VIF) value of less than 1.5 (i.e., VIF = 1.032) which means that multicollinearity does not occur. Third, the results of the analysis to examine the data distribution showed that the LITERACY variable set data came from a population with a multivariate normal distribution based on QQ-Plot following a straight-line pattern (Figure 2). Meanwhile, the QQ-Plot for the PERCHL variable set indicates that the assumption of a multivariate normal distribution in the population does not meet. Nevertheless, Pituch and Stevens (2015) suggest that canonical correlation analysis can still provide accurate and reliable results because the amount of response data in this study is very large (n = 109305).



(a) (b)

Figure 2. Q-Q Plot (a) LITERACY and (b) PERSCHL

Data analysis has been carried out on the response 109305 on the PERSCHCL and LITERACY variable sets. By using the help of RStudio and Microsoft Excel, the questions we asked in this research have been answered. We report the main results of our research in the order of the research questions that we proposed as follows.

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RQ 1: Is there a relationship between PERCHL and LITERACY?

Descriptive statistics of the LITERACY and PERSCHL that have been transformed on the same scale are presented in Table 2. The level of student perception obtained from the analysis using the GRM was transformed and obtained an average of 500.

In general, if we look at the set of LITERACY variables based on the points of statement on the two PERSCHL variables, the level of competition and cooperation in the learning environment in schools has a positive relationship with student literacy skills, be it MATH, READ, or SCIE (see Figure 3 and Figure 4).

In Figure 3, there is a tendency that students' literacy skills have a relationship that is directly proportional to students' perceptions of the level of competition in schools. However, there is one item, i.e., ST205Q03HA, that indicates the existence of an inverse relationship. Therefore, the interpretation of the variable will be more clearly confirmed through its canonical correlation coefficient.

Items that measure PERSCOOP exhibit different conditions. High literacy skills are obtained by students who have a perception of a not too high level of cooperation. Even the ST206Q03HA item shows no difference in average literacy skills in all dimensions of LITERACY (MATH, READ, and SCIE). Although different from the PERSCOMP variable, the results of the analysis in Figure 4 show that the lowest perception of the level of cooperation in schools is not associated with high literacy skills. Again, the canonical correlation coefficient will be used to explain the relationship between the two variables.

The distribution of student responses in the PERSCOMP and PERSCOOP items (see Figure 5) shows that most students do not show perceptions of high competition or cooperation in schools. In the PERSCOMP variable, it appears that most students show a perception of the existence of competition but with a level that is not too high. Meanwhile, in the PERSCOOP variable, it can be seen that most students show a perception of the existence of cooperation but which is not too high but higher than the level of competition. In other words, cooperation dominates the school climate more compared to competition.

The results of the canonical correlation analysis show that all variables have a positive and significant correlation. However, as shown in Figure 3 and Figure 4, the correlation coefficient between student perception variables and literacy skills variables is not high. In Table 3, the correlation coefficient between the variables included in the PERSCHL set and the variables included in the LITERACY set has a positive but not high enough correlation coefficient.

Table 2. Descriptive statistics

Variable	M	Min.	Max.	St. Dev.
MATH	469.3116	129.5555	825.1857	89.62972
READ	463.4535	158.6052	806.6986	96.00171
SCIE	467.5831	193.7475	843.2473	87.26432
PERSCOMP	500	282.5556	701.1539	100
PERSCOOP	500	269.405	686.2957	100

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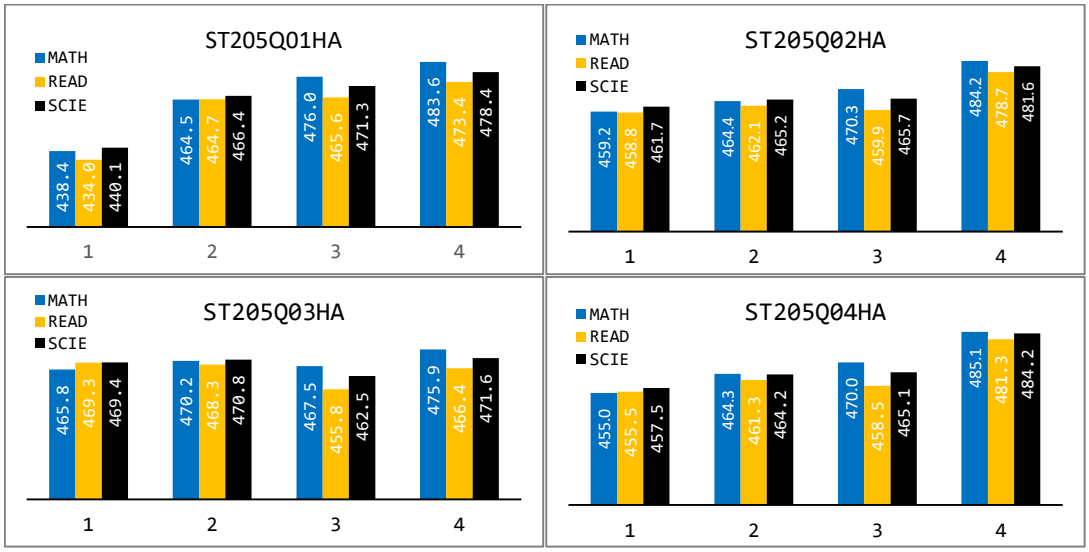

Figure 3. Average literacy of students based on perceptions of competition level in schools

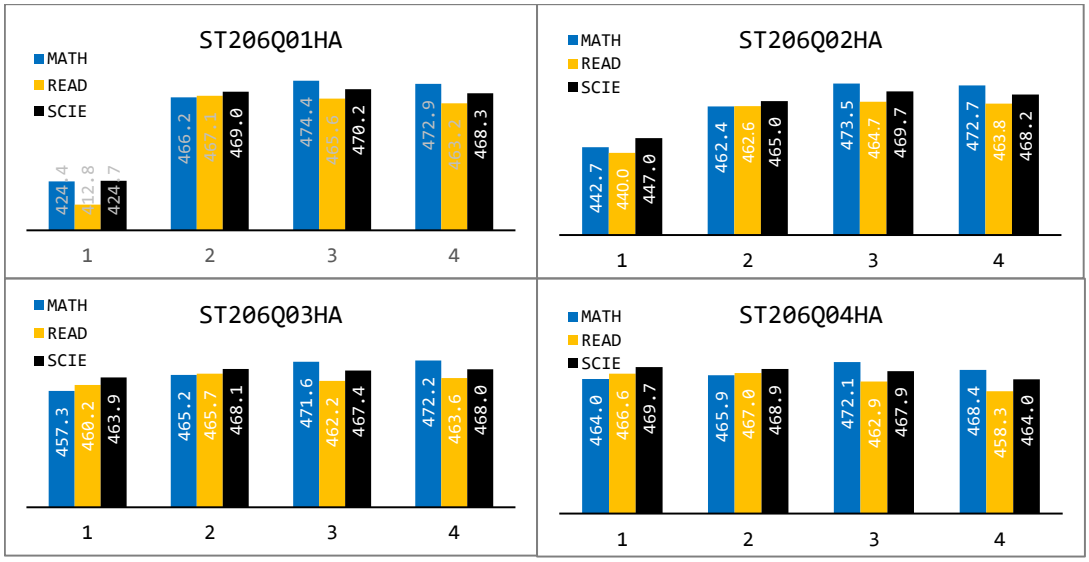

Figure 4. Average literacy of students based on perceptions of cooperation levels in schools

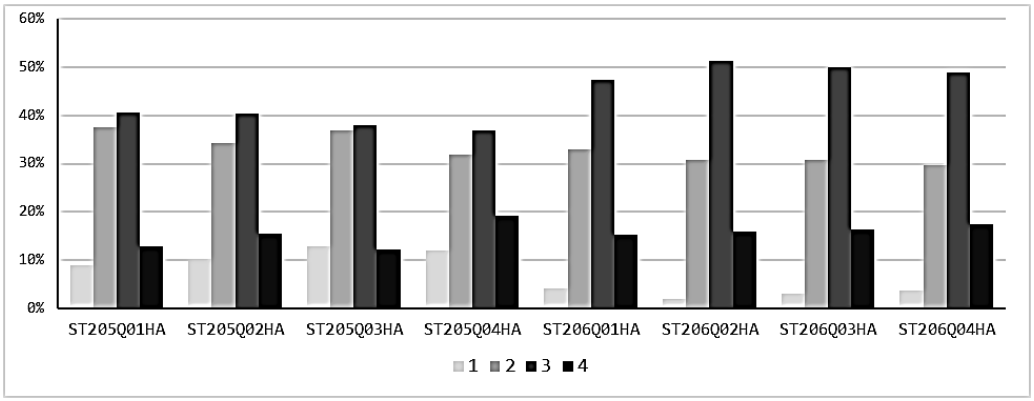

Figure 5. Response distribution on PERSCOMP and PERSCOOP items

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Table 3. Correlation between variables

	MATH	READ	SCIE	PERSCOMP	PERSCOOP
MATH	1	0.853	0.885	0.083	0.052
READ	0.853	1	0.911	0.036	0.05
SCIE	0.885	0.911	1	0.053	0.015
PERSCOMP	0.083	0.036	0.053	1	0.179
PERSCOOP	0.052	0.005	0.015	0.179	1

Table 4. F Approximation using Wilks' Lambda test statistics

	stat	approx.	df1	df2	p
1 to 2	0.98	320.62464	6	218600	0
2 to 2	0.99	45.41165	2	109301	0

Analysis of the canonical correlation yields two canonical functions equal to the number of variables in a smaller set of canonical variables, namely PERSCHL. Table 4 shows that the variance of the LITERACY variable can be explained 98.26% by two dimensions in the PERSCHL variable set. A *p* value that is less than 0.05 can be interpreted as two canonical functions formed significantly.

Furthermore, the canonical correlation of the two canonical functions formed shows small coefficients, namely 0.129 and 0.029. Although small, this result is significant because the *p* value is < 0.05. Therefore, it can be concluded that the PERSCHL variable has a positive and significant correlation to student literacy skills. As shown in Figure 3 and Figure 4, the correlation coefficient between the PERSCHL and LITERACY sets of variables is not high enough but significant. Thus, the hypothesis that students' perceptions of the school climate have a relationship with students' literacy skills is acceptable.

RQ 2: Which of the PERSCHL variables is the most related to students' literacy skills?

In order to answer the second question of this study, information from canonical loading was used. The results of the analysis produce an index of associative relationships between the variables contained in the PERSCHL variable set and the LITERACY variable set. The coefficient that is brought to life is included in the scheme as can be seen in Figure 6.

The correlation coefficient obtained describes the associative relationship between the PERSCOMP and PERSCOOP variables with their canonical variables namely PERSCHL, and the MATH, READ, and SCIE variables with their canonical variables LITERACY as shown in Figure 6. From these results, information was obtained that students' perceptions of the level of competition and the level of cooperation in schools have a relationship with their literacy skills. The resulting canonical correlation coefficient shows that perceptions of the level of competition have a stronger relationship than perceptions of the degree of cooperation. In the LITERACY variable set, mathematical literacy variables (MATH) have a stronger relationship compared to other variables, i.e., READ and SCIE. The correlation coefficient for MATH variables far surpasses the READ and SCIE correlation coefficients which only have coefficients of 0.223 and 0.362.

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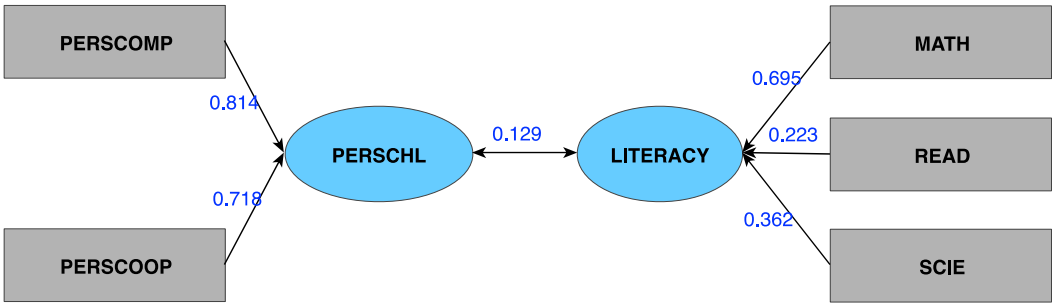

Figure 6. Coefficient of correlation between two set of variables

Discussion

The results of this study show that perceptions of the learning environment in schools are positively related to student literacy skills. This is evident from the positive and significant correlation across all canonical domains or variables. The results therefore have confirmed the previous studies that reveal students' positive perceptions of the learning environment at school are positively associated with student academic achievement (see Cuadrado et al., 2017; Parris et al., 2018)

The low correlation between the variables in the PERSCHL set and the LITERACY set (see Table 2) has implications for the low canonical correlation coefficient between the two sets of variables, as what has been mentioned by Pituch and Stevens (2015) that the high and low of the canonical correlation coefficient between the two sets of variables is in line with the high and low of the correlation coefficient between the variables in the two sets of variables. The results of this study also confirm the results of the study conducted by Demirtas-Zorbaz et al. (2021) that the perception of school climate has a positive and significant relationship, but the relationship is not strong.

A small correlation coefficient on the variable of students' perceptions of the school climate (PERSCHL) does not mean that efforts to increase the level of cooperation will not have a major impact on improving student literacy skills. The condition is relevant to the distribution of student responses (Figure 5) which shows that very few students feel the existence of competition and cooperation is very high or frequent in school. In fact, the two variables are positively associated with literacy skills, both mathematics, reading, and science. Presenting a competition situation in a learning environment is proven to be able to improve the skills of 21st-century students (Walan & Mc Ewen, 2018). Meanwhile, cooperation is needed to solve collective problems faced in social life, for example environmental problems (Cuadrado et al., 2017).

Considering that cooperation is inseparable from collaboration which is one of the important competencies in the 21st-century, the changes in the learning process in the classroom today emphasize more on the importance of collaborating with each other. Innovations in learning models are now increasingly emphasizing the importance of collaborating and collaborating in the learning process, for example the problem-based learning model (PBL) (Djidu et al., 2021; Djidu & Jailani, 2018) and project-based learning (PjBL) (Wu & Wu, 2020), which emphasize collaborative activities to solve a given problem. Cooperation that encourages social interaction in schools and it has also been shown to increase the level of student participation in learning.

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The combination of competition and cooperation is necessary to facilitate the development of students' literacy skills as well as collectively. This combination model can be done by combining teamwork and competition between groups as reported by Liu et al. (2021) who transformed from individual competition to social interaction through a mobile team-based competition model. Innovations like these are necessary to prepare for situations of competition and cooperation in real life.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study show a positive relationship between students' perceptions of the learning climate in schools and their literacy skills. The results of the analysis of PISA data in 2018 on the climate of competition and cooperation in this study provide the following conclusions. First, perceptions of the level of competition and cooperation in schools are positively related but with a small coefficient. Second, competition has a higher relationship with literacy skills compared to cooperation but the difference between the two is not too high. Third, competitions and cooperation in schools still need to be developed to foster students' literacy skills individually and collectively.

Which is more related to students' literacy skills, competition or cooperation? The answer to the question is that competition has a stronger relationship, but it is not much different from cooperation. This means that these two variables related to the school climate can be developed to optimize student literacy skills.

Programs to improve the school climate towards a competitive and cooperative learning environment urgently need to be considered by policymakers. Being competitive does not mean creating a mutually debilitating school climate but creating situations that can trigger students to study harder and strive harder to improve their academic achievement (literacy). Likewise, the cooperative environment also needs to be optimized by involving students in various learning activities through teamwork so that collaboration and cooperation are expected to improve their literacy skills. Eventually, we argue that a learning or educational model that combines competition and cooperation needs to be developed to foster students' literacy skills individually and collectively.

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APPENDIX

Data on the results of estimating the level of student perception of competition and cooperation, as well as literacy are available on the following link: https://drive.google.com/file/d/1oQylGx3jIYScq3Q8-5SX76LLNGuOxYRe/view?usp=share_link