

The Effect of Academic Grades in Chinese and Mathematics on Academic Grades in English for Middle School Students Based on CEPS Data

Ziying Zhao

School of Education, Shanghai International Studies University, Shanghai 201620, P.R.China

ABSTRACT

This paper adopts the 2013 China Education Panel Survey (CEPS) data and uses STATA to analyze them in order to study the impact of junior high school students' Chinese and mathematics academic grades on their English academic grades. Cognitive ability test standardized score(based on 3PL model) had the highest correlation with English academic grades and had the greatest impact on it, greater than that of math and Chinese academic grades and students' emotional engagement in learning. Secondly, students' academic grades in mathematics and Chinese as independent variables, English academic grades as the dependent variable, and students' emotional engagement in learning based on the questionnaire information were established as control variables together with students' standardized scores on the cognitive ability test, and regression equations were carried out to test the results. The results found that Chinese academic grades have stronger explanatory power for English academic grades compared to junior high school students' math academic grades. Students' academic grades in mathematics and Chinese can directly affect their English academic grades, and can also indirectly affect it through the mediation of students' cognitive ability.

KEYWORDS

English academic grades; regression analysis; China Education Tracking Survey; cognitive ability; students' emotional engagement in learning

1 Introduction

In our country's education system, academic performance is an important indicator of the effectiveness of student learning, while the checking and evaluation of academic grades is a significant part of school education that controls, motivates and regulates the teaching activities and identifies the effectiveness of classroom instruction. In China's junior high schools, the checking and evaluation of academic grades is a widely used means of learning evaluation. Teachers and school leaders can find out the direction of improvement in teaching and take measures accordingly, besides students and their parents can also keep track of their students' learning. The subjects in examination reflecting academic achievements cover all the subjects of study prescribed by the State, and the focus of junior high school students' academic performance includes, but is not limited to, English, mathematics and Chinese.

According to the *Statistical Bulletin on the Development of National Education in 2022* released by the Ministry of Education, there are 51.260 million students enrolled in junior high school in China.

Unlike primary education, junior high school is an important learning stage for young learners, not only are students required to comprehend knowledge stated in textbooks, but also to be adept at logically analyzing and solving problems using what they have learned in class, and to integrate those knowledge and skills while mastering the latent knowledge links between each course and each subject. As a result, the connection between the subjects of Chinese, mathematics and English, which are the key subjects for junior high school students, is an important research topic to enhance teaching and learning in classrooms. In this regard, factors affecting English academic performance have been a heated topic among research scholars cultivating in fields including second Language acquisition, learning motivation, and cognition. In addition, under the double Reduction policy, exploring the interdisciplinary connections among those key subjects of Chinese, mathematics, and English is an important research topic to promote the integration and coherence of the subjects, to reduce students' pressure, and to optimize the teaching and learning in junior high school courses. In short, through the study of correlation between Chinese, mathematics, and English academic grades, researchers can better provide important ideas for teachers to promote students' interdisciplinary thinking and learning skills.

2 Literature Review

In recent years, researchers based on Chinese, mathematics and English subjects have focused on exploring the integration of subjects under the perspective of "double reduction" policy and the cultivation of abilities required by subject learning, besides, the integration of pedagogies between subjects in pursuit of teaching reform. But fewer scholars have paid attention to the correlation between the academic grades of those subjects and investigated the internal reasons for it. The existing literature points to the following information.

First of all, inchoate studies in the early 21st century showed that Chinese and mathematics academic performance was significantly negatively correlated with English academic performance. In this regard, scholars believe that English learning is unique in terms of learning characteristics, and secondary school students have relatively limited learning resources such as learning energy and intellectual factors, while English learning consumes and occupies a greater portion of learning resources, leading to competition between the above subjects[1] (Gao Jia, 2002), which suggests that English learning has a negative impact on Chinese and mathematics learning. Subsequent scholars have refuted the above view after more detailed investigations by controlling variables and enlarging the sample size. First of all, in terms of the influence of mathematics academic grades on English academic grades, some scholars point out that the two are significantly positively correlated, and suggest that the learning pressure and anxiety generated by mathematics learning will affect English learning together and cause a decline in academic grades[2]. Afterwards, some scholars analyzed English learning ability and mathematics learning ability to find the correlation between the two academic grades, pointing out that the English logical thinking ability of secondary school students is crucially correlated with their mathematics learning ability, and verified the prediction effect of the mathematics learning ability on the English logical thinking ability through the regression equations, which further confirmed the positive correlation between the two subject grades [3]. Second, in terms of the correlation between Chinese academic grades and English academic grades, scholars explained the positive influence of Chinese academic grades on English academic grades by pointing out the connection between learning abilities of two subjects, arguing that Chinese language learning can help learners to sort out the language input they have received and make learners use the language at the highest level, thus enhancing English language management. [4]

3 Research Design

3.1 Research questions

This study addresses the following questions:

- Does middle school students' academic grades of math and Chinese have an impact on their academic grades in English? Is the impact positive or negative?
- Do middle school students' math and Chinese scores correlate more or less strongly with their English scores than students' microcosmic factors, including affective engagement in learning and cognitive ability?

3.2 Statistical model

In order to explore the relationship between math and Chinese academic grades and English academic grades, an empirical model was first developed. Since the explanatory variables are expressed as continuous numerical variables, the study chose multiple linear regression model for analysis.

$$ye = a_0 + \beta_m * x_m + \beta_c * x_c + \mu$$

ye is the midterm English test grades of the study participants taken in 2013, the x_m and x_c are the math and Chinese academic scores, and a_0 is the intercept item, and β_i is the slope of the independent variable, and μ is the residual term.

In order to further explore the influence of other factors on English grades, based on previous studies, two variables of English learning affective commitment and cognitive ability test-standardized scores(based on 3PL model), which have an important influence on English academic grades, are added here [5,6] . The equation is expanded as follows:

$$y_e = a_0 + \beta_m * x_m + \beta_c * x_c + \beta_i * x_i + \beta_r * x_r + \mu$$

Among them, x_i is the participants' affective engagement in English learning, and x_r is the cognitive ability test score variable.

3.3 Data sources and processing

The data for this study came from the China Education Panel Survey (CEPS). Firstly, the raw data were cleaned by removing irrelevant variables, retaining a total of 10 sets of data including standardized junior high school students' scores in Chinese, mathematics and English in the 2013 midterm exam, and cognitive ability test scores, etc. This research supplemented or individually cleared the missing data, finally obtaining 17103 valid samples.

This paper refers to Guo Jidong's content division and questionnaire design of emotional engagement in English learning[5], and based on the information of existing data, this study groups the questions of the questionnaire, integrating them into the following five categories, which are: students' satisfaction with the school, the value of English learning, confidence in learning, interest in learning, and sense of belonging to the school. Since the selected data are all four-point integral scores, the integration method adopted here is to add up the scores of different items in the same sample, and the final data obtained from small to large reflect the students' degree of commitment from low to high. Subsequently, the scores of the five categories in the individual samples were summed to create a variable called "students' emotional engagement in learning". The creation of this variable helped to complement the regression model and to explore more precisely the power of the explanations of the model. The following table shows the variables that were integrated and the questions that comprised them.

Table 1 Composition of variables on the level of students' emotional engagement in learning

Integration of variable names (constituent variables)	Questionnaire	Question options
Confidence to learn	I was able to articulate my opinion very clearly My reflexes are quick. I can learn new things quickly.	
Learning value	Regarding the main course, do you agree with the following statement - Math is helpful for my future With regard to the main course, do you agree with the following statement - Chinese is helpful for my future Regarding the main course, do you agree with the following statement - English is very helpful for my future	
Interest in learning	I try to go to school even if I'm not feeling well or if there's some reasons to stay home. Even if I don't like it, I'll do my best. Even if it takes me a long time to finish my homework, I keep trying my best to do it.	1 Completely disagree 2 Comparative disagree
Sense of belonging to the school	Regarding school life, do you agree with the following statements - I often participate in activities organized by my school or class Do you agree with the following statements about school life - I feel close to people in this school Do you agree with the following statements about school life - I am bored in this school Do you agree with the following statements about school life - I wish I could go to another school	3 Comparatively agree 4 Completely agree
Satisfaction with class	Do you agree with the following statements about school life - Most of my classmates are friendly to me Do you agree with the following statements about school life - I think I get along with people easily Do you agree with the following statements about school life - My class has a good class manners	

3.4 Description of variables

The base sample selected for this study is well represented: (1) the gender distribution of students is balanced, with male students accounting for 50.60% and female students accounting for 49.40% (2) There is a wide distribution of regions, and the sampling is scientific, with the average level of education of the population and the proportion of the mobile population as the stratification variables. Descriptive statistics of the main variables are shown in Table 3.

4 Empirical Analysis

Based on the statistical model of junior high school students' academic performance, this study explores the relationship between students' academic grades in English and their academic grades in mathematics and Chinese. The model can obtain more representative regression results with sufficient sample size.

Table 2 Descriptive statistics of main variables

Variable	N	Average value	P50	(Statistics)	Min	Max.
				standard deviation		
Sense of belonging to the school	17103	8.885	9.000	1.901	4.000	16.000
Interest in learning	17103	9.947	10.000	2.008	3.000	12.000
Satisfaction with class	17103	9.605	10.000	2.067	3.000	12.000
Learning value	17103	9.823	10.000	2.017	3.000	12.000
Confidence to learn	17103	9.097	9.000	1.941	3.000	12.000
Emotional Engagement of learning	17103	47.357	48.000	6.112	16.000	64.000
Academic grades in English	17103	70.351	72.433	9.760	11.439	107.815
Academic grades in mathematics	17103	70.333	72.220	9.786	8.422	145.115
Academic grades in Chinese	17103	70.367	71.809	9.725	-2.399	98.475
Cognitive ability test-standardized Score(based on 3PL model)	17103	0.038	0.024	0.853	-2.029	2.710

4.1 Regression analysis of junior high school students' academic grades in English and academic grades in Mathematics and Chinese arts

Based on formula one, the author takes Chinese academic grades and math academic grades as the main control variables to examine the effects of the above variables on English academic grades. Further, based on Equation 2, the author introduces two variables, namely, students' emotional engagement of learning and scores of cognitive ability test, in order to improve the model and increase the explanatory strength of the model. The results of the regression equation based on the above are shown in Table 3.

Table 3 Regression analysis of the relationship between academic grades in English and academic grades in math and Chinese arts

Dependent variable: academic grades in English	Academic performance in mathematics	Academic performance in Chineses	Learning to be emotionally engaged	Standardized scores on the Student Cognitive Abilities Test
Coefficient value	0.3702389	0.4516089	0.0660185	0.305972
(Statistics) standard deviation	0.0064332	0.0063008	0.0082714	0.0626092
P> t	0.000	0.000	0.000	0.000
Sample size	17103			
Prob > F	0.0000			
R ²	0.5648			
Adj R ²	0.5647			
F	5547.91			

The following preliminary information can be obtained from Table 3.

In this study, regression analysis was conducted with students' English academic grades as the dependent variable, and students' Chinese academic grades, mathematics academic grades, emotional engagement in learning and scores on the cognitive ability scores, which represents the level of cognitive abilities of the students, as the independent variables. The decidable coefficient of the regression model, R^2 , is 0.5648, and the Adj R^2 is 0.5647, which indicates that the model has more than 50% explanatory power for English academic grades, and the fit is good. The F-value is 5547.91 and Prob>b is 0.0000, which is less than 0.05, proving that the joint significance of the model variables is strong. In addition, the regression coefficients between the four independent variables and the dependent variable are all more significant and have some explanatory strength.

In order to further compare the explanatory strength of each variable on English academic grades, the study regressed each of the above to compare the influence of each English academic grades influencing factor, and the results are shown in Table 6.

Table 4 Regression results for independent and dependent variables respectively

Dependent variable: academic grades in English	Academic grades in mathematics	Academic grades in Chinese	Learning to be emotionally engaged	Cognitive ability test-standardized scores
Coefficient value	0.649804	0.6849711	0.3056045	3.376733
$P> t $	0.000	0.000	0.000	0.000
R^2	0.4245	0.4659	0.0366	0.0872
Adj R^2	0.4244	0.4658	0.0366	0.0871
F	12613.10	14915.55	650.24	1632.91

First, from the regression coefficients, the students' cognitive ability test has the most significant effect on English academic grades, followed by Chinese academic grades, mathematics academic grades, and lastly, students' emotional engagement in learning. The level of significance of all four regression equations is 0.000, which is a high reflection. Secondly, from the perspective of decidable coefficient R^2 , the explanatory power of the four independent variables for English academic grades are, in descending order, Chinese grades, mathematics grades, scores of students' cognitive ability test and emotional engagement, respectively. Among them, there is little difference in the explanatory power between math and Chinese academic grades, and there is a significant difference in the explanatory strength between the two types of academic grades and the remaining two variables.

4.2 The mediating role of students' cognitive abilities in academic grades in Chinese and Mathematics and academic grades in English Chinese

4.2.1 The mediating role of students' cognitive abilities between academic grades in Chinese and academic grades in English

Table 5 Sequential test of students' cognitive ability (M) as a mediating effect of academic grades in Chinese and English

	Standardized regression equation	Regression coefficient test
Initial step	$y = 0.454x_1$	$SE=0.00629, p<0.01$
Second step	$m = 0.00758x_1$	$SE=0.000767, p<0.01$
Third step	$y = 0.452x_1$	$SE=0.00630, p<0.01$
	0.306m	$SE=0.0626, p<0.01$

According to the test method of mediating effect proposed by Wen Zhonglin [7], after confirming that all variables were standardized, regression analyses were carried out in order, and regression equations were established respectively: the regression equation of the Chinese academic grades (x_1) on the English academic performance (y); The regression equation of Chinese academic grades (x_1) on the standardized score of students' cognitive ability test (m); the regression equation of Chinese academic grades (x_1) and the standardized score of students' cognitive ability test (m) on English academic grades (y). The results of the mediating effect analysis of students' cognitive ability show that the test results of the first, second and third steps are significant ($p<0.01$), so the mediating effect of students' cognitive ability is significant.

4.2.2 The mediating role of students' cognitive abilities between academic grades in math

and academic grades in English

Table 6 Sequential test of students' cognitive ability (M) as a mediating effect of academic grades in Mathematics and English

	Standardized regression equation	Regression coefficient test
Initial step	$y = 0.454x_2$	SE=0.00629, $p < 0.01$
Second step	$m = 0.00758x_2$	SE=0.000767, $p < 0.01$
Third step	$y = 0.452x_2$	SE=0.00630, $p < 0.01$
	0.306m	SE=0.0626, $p < 0.01$

Similarly, the above steps were followed to test the mediating role of students' cognitive ability between mathematics and English academic grades, and then conduct regression analyses on mathematics and English academic grades, students' standardized test scores on cognitive ability, affective commitment to learning, and Chinese academic grades in turn, and establish regression equations, respectively, i.e., the effect of mathematics academic grades (x_2) on English academic grades (y); the regression equation of math academic grades (x_2) on the standardized score of students' cognitive ability test (m); the regression equation of math academic grades (x_2), the regression equation of standardized scores on the Test of Student Cognitive Abilities (m) on English academic grades (y) regression equations. The results showed that the regression tests of the first, second and third steps were all significant ($p < 0.01$), so the mediation effect was significant.

5 Findings

5.1 Impact of math and Chinese academic grades on English academic grades

The results of this study showed that middle school students' academic grades in Chinese and mathematics are significantly and positively correlated with their academic grades in English, which is consistent with the theoretical hypothesis. Compared with junior high school students' academic performance in grades, Chinese grades explains more strongly. It may be based on the fact that Chinese and English are both language teaching disciplines, and Chinese learning provides practical methods for English learning. Mathematics learning shares logical thinking with English learning, and the similarity of learning methods will have a more significant impact on students than logical thinking and analytical ability. Thus, the results of this study further demonstrate the importance of subject integration.

5.2 Analysis of other micro-factors affecting academic grades of English

In the present study, it turned out that the explanatory power of math and Chinese academic grades for English academic grades was greater than that of students' emotional engagement in learning and scores on the cognitive ability test. Student emotional engagement was the smallest and smaller than student cognitive ability. This result may be due to the lack of scientific calculation and definition of the variable of students' affective engagement in learning in the study, so the result is for reference only.

Second, the correlation analysis of all independent and control variables with English academic grades showed that students' cognitive ability had the highest correlation and the greatest impact on English academic grades, greater than math and Chinese academic grades and emotional engagement. This result is a direct indication of the importance of cognitive ability in the process of students' participation in the examination for academic grades. Increased cognitive awareness of subject matter knowledge and subject matter testing can greatly contribute to student

performance in subject matter learning. It also demonstrates that schools should not only teach junior high school students subject-specific knowledge, but also focus on the development of students' cognitive ability for the subject of English and the English grades test.

5.3 Mediating role of cognitive ability between academic grades in Mathematics, Chinese arts, and academic grades in English language

This study noticed through the mediating role test that students' academic grades in math and Chinese can directly affect junior high school students' academic grades in English, and can also indirectly affect it through the mediating role of students' cognitive abilities. Cultivating students' Chinese and math subject learning abilities and improving students' Chinese and math academic grades can help promote English academic performance, and strategies that focus on with cultivate students' cognitive abilities do good to English learners that further improves their English skills. Based on a large sample of data, this study explored the factors that influence English academic performance. However, the setting of variables still has room for improvement in terms of scientific validity. For the mediation of cognitive level test scores and emotional engagement in learning in the model, different methods of testing can be implemented to verify the scientificity of the results, such as implementing sobel test.

Notes on contributors

Ziying Zhao is undergraduate of School of Education, Shanghai International Studies University, and her research field is English Education.