



# Exploration of the Relationship between Classroom Environment and Academic Performance in Distance Education

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**Abstract.** This study uses the PISA database to explore the impact and mechanism of classroom environment on academic performance in distance education. The analysis results show that (1) after controlling for family background and daily learning time, the classroom environment has a significant positive predictive effect on academic performance; (2) Subject self-efficacy partially mediates the relationship between classroom environment and academic performance; (3) The direct effect of classroom environment on academic performance and the mediating effect of subject self-efficacy are all moderated by teaching media (remote and offline). Moreover, in remote education, the predictive effect of classroom environment on academic performance, classroom environment on self-efficacy, and self-efficacy on academic performance are weaker than in online teaching. This study is conducive to revealing the pathway of the impact of classroom environment on academic performance and the influence of classroom environment on academic performance in distance education, which has certain enlightening significance for the implementation of distance education in secondary education.

**Keywords:** Distance education; Subject self-efficacy; Academic performance; Classroom environment;

## 1 Introduction

In real life, the implementation of formal secondary education is usually carried out offline, but with the development of emerging technologies, distance education has also become an important learning tool. The implementation of PISA2022 provides researchers with a window to observe the teaching effectiveness of distance education in secondary education in depth. The official analysis report of PISA points out that compared to 2015 and 2018, the trend of declining performance in this test is very obvious, which is related to the occurrence of the epidemic. Meanwhile, this report also points out that a good classroom environment can significantly improve academic performance.<sup>[1]</sup> So, is there a significant difference between the classroom environment of distance education and offline? If it exists, whether it will significantly affect the level

of academic performance, and what is the mechanism of action, is a question worth studying.

### 1.1 Classroom Environment and Academic Performance

Fraser defines "classroom environment" as the perception or feeling of students or teachers towards the class or classroom, believing that the learning environment is a potential factor that determines student development and cannot be ignored by any researcher who hopes to improve the quality of education and teaching.<sup>[2]</sup> The attention of the educational community to the classroom environment stems from the shift of educational focus from "teaching" to "learning", which is reflected in the transformation of classroom teaching from "teaching organization methods" to "learning environment design".<sup>[3]</sup> Some scholars believe that research on the classroom environment should not only focus on the physical environment<sup>[4]</sup>, More attention should be paid to students' perception of the classroom environment.<sup>[5]</sup> There are two research methods in the study of students' perception of the classroom environment: one is the objective research method, in which the participants are experts who evaluate the classroom environment through observation and analysis; One is subjective research method, with students as the main participants, mainly using questionnaire survey method to understand students' self classroom perception.<sup>[6]</sup> Previous studies have shown that whether in university<sup>[7]</sup>, middle school<sup>[8]</sup>, or elementary school<sup>[9]</sup> The classroom environment can significantly and positively affect students' academic performance. Therefore, H1: Classroom environment positively predicts academic performance.

### 1.2 Self efficacy

Self efficacy was proposed by psychologist Bandura, who believes that self-efficacy is the level of confidence people have in their ability to use their skills to complete a certain work behavior. Luthans provides a more specific definition: "Self efficacy refers to an individual's precise belief (or confidence) in their ability to mobilize necessary motivation, cognitive resources, and a series of actions to successfully complete a specific task in a certain context."<sup>[10]</sup> Previous studies have found that in offline, subject self-efficacy can be mediated by learning optimism, significantly predicting students' academic performance.<sup>[11]</sup> Under distance education, the influence of internal learning motivation on subject self-efficacy can also significantly affect learning outcomes.<sup>[12]</sup> Meanwhile, some studies have also used self-efficacy as a mediator to investigate the relationship between certain other factors and academic performance.<sup>[13]</sup> These studies indicate that self-efficacy can significantly positively predict academic performance. Therefore, this study proposes that H2: subject self-efficacy plays a mediating role in the relationship between classroom environment and academic performance.

### 1.3 Remote and offline

Distance education and offline, as different teaching media, can have a significant impact on student academic performance. Related research mainly focuses on the design

of teacher support tools<sup>[14]</sup>, student self-directed learning guidance<sup>[15]</sup>, There is relatively little research on distance education in secondary education. Therefore, the innovation of this study lies in exploring whether the mediating effect of self-efficacy on classroom environment and academic performance also significantly exists in distance education in secondary education by comparing the differences between distance education and offline. This is also the core issue that this study aims to solve. Therefore, this study selected data from countries that had implemented full distance education for more than one year before the 2022 evaluation as data for distance education, and selected data from the same country in 2018 as data for offline. Then, these two variables were set as moderating teaching media, focusing on examining the differences between classroom environment, subject self-efficacy, and academic performance in distance education and offline. Therefore, it is proposed that H3: teaching media significantly moderates the mediating effect of subject self-efficacy in the classroom environment and academic performance.

Given that during the epidemic, students mainly participate in formal teaching through online live streaming, which makes the influence of teachers on student learning weaker than offline at the current stage of remote education. Student learning is more focused on self-directed learning. As a result, students may not be able to accurately perceive their self-efficacy in certain subjects due to a lack of peer and learning test references. Therefore, H4: The predictive effect of classroom environment on self-efficacy and academic performance in distance education is weaker than that in offline, and the predictive effect of self-efficacy on academic performance is also weaker than that in offline.

In summary, this study uses subject self-efficacy as a mediating variable and teaching media (remote, offline) as moderating variables to explore the relationship between classroom environment and academic performance. The hypothetical diagram of its model is as follows (as shown in Figure 1):

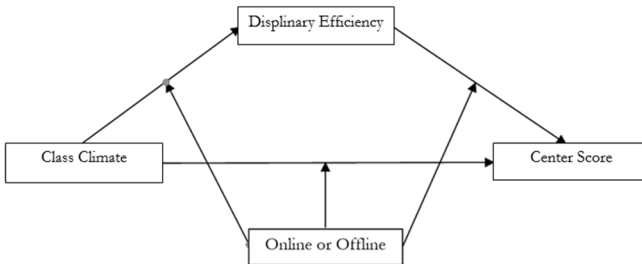


Fig. 1. Hypothetical Model

## 2 Research Method

### 2.1 Data Sources and Processing

This study used the Programme for International Student Assessment Database (PISA) led by the International Organization for Economic and Trade Cooperation (OECD) to

select countries and regions that have been closed for more than 1 year and have implemented distance education for all students from the PISA2022 database based on test questions ST347Q01JA and SC214Q01JA as data for distance education. At the same time, in order to minimize the impact of regional differences, this study selected the same countries and regions from the PISA2018 database as offline data based on the above results, merged and cleaned the data, and used SPSS 25.0 and the SPSS macro program PROCESS developed by Hayes (2013) to organize and analyze the data.

## **2.2 Variable Definition**

### **2.2.1 Classroom Environment**

PISA selects one subject as the focus of each round, PISA2018 is reading, and PISA2022 is mathematics. This study selected the reading classroom environment index (DISCLIM) in 2018 and the mathematics in 2022 as the research objects.

### **2.2.2 Academic Performance**

PISA estimates the probability distribution of each student's level in science, mathematics, and reading tests using Project Response Theory (IRT), and presents scores (Plausible Value, PV) with 10 pseudo true values. This study intends to take PV1 to understand the overall literacy level of students in their subjects. The average of PV1 in the three subjects is then centralized, and the centralized score is obtained as the research object.

### **2.2.3 Subject Self-Efficacy**

PISA measures subject self-efficacy by assessing the competency of students in key subjects through a questionnaire. After evaluating their ability to solve several subject problems raised in the questionnaire, students are asked to choose the following four options: "1. Not at all confident", "2. Relatively confident", "3. Confident", "4. Very confident", and ultimately generate a subject competency indicator (SCREADCOMP). This study intends to select the Reading Competency Index (SCREADCOMP) of PISA2018 and the Mathematical Competency Index (MATHEFF) of PISA2022 as the research objects.

### **2.2.4 Teaching Media (Online Or Offline)**

During the PISA2018 testing period, schools mainly used offline, so the data for 2018 was set as variable 0. The data for PISA2022 is set to variable 1 as the data for distance education

### **2.2.5 Control Variables**

Family background has a high explanatory power on academic performance, therefore the family socioeconomic and cultural status index (ESCS) in PISA was selected as the control variable. In addition, individual learning time can also affect grades, but

PISA2018 presents a continuous variable and PISA2022 is a level variable. Therefore, PISA2018 is recoded as a level variable and merged into a control variable.

### 3 Result Analysis

#### 3.1 Descriptive Statistics, Independent Sample T-Tests, and Correlation Analysis

The independent sample t-test results (Table 1) indicate that the classroom environment ( $p < 0.001$ ,  $M \pm SD = 0.022 \pm 0.989$ ), academic performance ( $p < 0.001$ ,  $M \pm SD = 448.025 \pm 85.587$ ), subject self-efficacy ( $p < 0.001$ ,  $M \pm SD = -0.164 \pm 1.058$ ), and daily learning time ( $p < 0.001$ ,  $M \pm SD = 3.45 \pm 1.675$ ) of distance education are significantly lower than those of offline ( $p < 0.001$ ,  $M \pm SD = 0.094 \pm 1.059$ ), Academic performance ( $p < 0.001$ ,  $M \pm SD = 486.773 \pm 90.116$ ), subject self-efficacy ( $p < 0.001$ ,  $M \pm SD = 0.057 \pm 0.976$ ), daily study time ( $p < 0.001$ ,  $M \pm SD = 5.24 \pm 0.745$ ), but family background ( $p < 0.001$ ,  $M \pm SD = 2.529 \pm 16.553$ ) is significantly higher than offline. This may be because students from schools that can be closed for one year and receive full distance education have a good family background.

**Table 1.** summarize statistic and comparison of main variables between online and offline

Variable	Mean	SD	Group	Mean $\pm$ Standard Deviation	95%CI		T-test
					Upper	Lower	t-value
Mean	482.519	90.445	offline	486.773 $\pm$ 90.116	487.125	486.420	74.595***
			online	448.025 $\pm$ 85.587	448.980	447.070	
Disiplinary Efficacy	-0.266	1.103	offline	0.057 $\pm$ 0.976	0.061	0.053	34.989***
			online	-0.164 $\pm$ 1.058	-0.152	-0.176	
Class Climate	0.086	1.051	offline	0.094 $\pm$ 1.059	0.098	0.090	11.887***
			online	0.022 $\pm$ 0.989	0.033	0.011	
Daily Study Time	5.042	1.055	offline	5.24 $\pm$ 0.745	5.24	5.24	184.916***
			online	3.45 $\pm$ 1.675	3.47	3.43	
Family Status	0.172	5.632	offline	-0.119 $\pm$ 1.033	-0.115	-0.123	-28.096***
			online	2.529 $\pm$ 16.553	2.714	2.344	

\*\*\* $p < .01$ , \*\* $p < .05$ , \* $p < .1$

The partial correlation analysis results (Table 2) after controlling for learning time, family background, and school background indicate that subject self-efficacy is positively correlated with score and disclosure climate ( $p < 0.001$ ), while subject self-efficacy in remote teaching is significantly lower than that in offline ( $p < 0.001$ ). Academic performance is significantly positively correlated with classroom environment ( $p < 0.001$ ), and distance learning academic performance ( $p < 0.001$ ) and classroom environment ( $p < 0.001$ ) are significantly lower than offline.

**Table 2.** correlation analysis of main variables

Variable	Disiplinary Efficacy	Academic achievement	Class Climate	Online or Offline
Disiplinary Efficacy	1.000			
Academic achievement	0.242***	1.000		
Class Climate	0.110***	0.107***	1.000	
Online or Offline	-0.070***	-0.134***	-0.021***	1.000

\*\*\* $p < .01$ , \*\* $p < .05$ , \* $p < .1$

### 3.2 Moderated Mediation Model Testing

According to Wen Zhonglin and Ye Baojuan (2014), the moderated mediation model test requires testing the parameters of three regression equations. Equation 1 estimates the moderating effect of teaching media (online or offline) on the relationship between classroom environment and academic performance, while controlling for family background and study time. Equation 2 estimates the moderating effect of teaching media (online or offline) on the relationship between classroom environment and subject self-efficacy. Equation 3 estimates the moderating effect of teaching media (online or offline) on the relationship between subject self-efficacy and academic performance.

The processing results after parameter centralization indicate (Table 3) that in Equation 1, the classroom environment significantly positively predicts academic performance ( $\beta = 8.912$ ,  $t = 53.24$ ,  $p < 0.001$ ), H1 holds. And the interaction between classroom environment and teaching media has a significant predictive effect on academic performance ( $\beta = -2.453$ ,  $t = -4.57$ ,  $p < 0.001$ ), indicating that teaching media significantly moderates the relationship between classroom environment and academic performance.

The classroom environment in Equation 2 significantly positively predicts subject self-efficacy ( $\beta = 0.093$ ,  $t = 50.24$ ,  $p < 0.001$ ), and the interaction term between classroom environment and teaching media has a significant predictive effect on subject self-efficacy ( $\beta = 0.081$ ,  $t = 13.57$ ,  $p < 0.001$ ) This indicates that teaching media significantly moderates the relationship between classroom environment and subject self-efficacy.

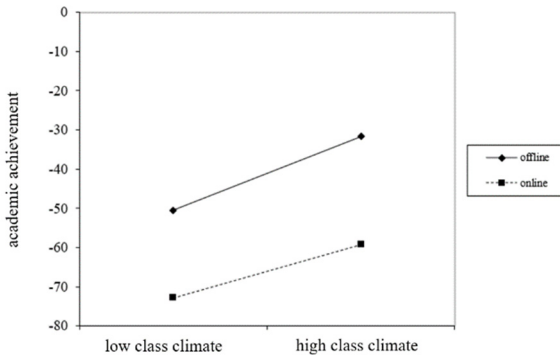
Equation 3: Significant positive prediction of academic scores in classroom environment ( $\beta = 6.975$ ,  $t = 42.55$ ,  $p < 0.001$ ), subject self-efficacy significantly positively predicts academic scores ( $\beta = 20.844$ ,  $t = 117.22$ ,  $p < 0.001$ ), and partially mediate the impact of classroom environment on academic performance, with a relative effect of 23.80%, H2 holds. The interaction between classroom environment and teaching media has a significant predictive effect on academic performance ( $\beta = -3.501$ ,  $t = -6.62$ ,  $p < 0.001$ ), the interaction term between subject self-efficacy and teaching media has a significant predictive effect on academic performance ( $\beta = -3.583$ ,  $t = -7.11$ ,  $p < 0.001$ ), in summary, teaching media play a moderating role in the impact of classroom environment on academic performance, classroom environment on subject self-efficacy, and subject self-efficacy on academic performance, i.e. regulating the direct effect of classroom environment on academic performance and the mediating effect of subject self-efficacy, H3 is established.

**Table 3.** an examination of the moderating mediating effect of class climate on academic achievement

Variable	Reg1 Academic achievement			Reg2 Disiplinary Efficacy			Reg3 Academic achievement		
	$\beta$	t	95%CI	$\beta$	t	95%CI	$\beta$	t	95%CI
Daily Study Time	8.83	47.23	[8.470, 9.203]	0.02	11.45	[0.020, 0.028]	8.40	46.06	[8.046, 8.762]
Family Status	0.83	27.95	[0.780, 0.898]	0.00	10.45	[0.003, 0.004]	0.76	26.02	[0.704, 0.819]
Class Climate	8.91	53.24	[8.584, 9.240]	0.09	50.24	[0.089, 0.097]	6.97	42.55	[6.654, 7.296]
Online or Offline	-24.720	-38.84	[-25.968, -23.473]	-0.177	-25.14	[-0.191, -0.163]	-21.581	-34.57	[-22.804, -20.357]
Class Climate $\times$ Online or Offline	-2.453	-4.57*	[-3.506, -1.400]	0.081	13.57	[0.069, 0.092]	-3.501	-6.62*	[-4.547, -2.469]
Disiplinary Efficacy							20.844	117.22	[20.495, 21.192]
Disiplinary Efficacy $\times$ Online or Offline							-3.583	-7.11*	[-4.571, -2.595]
R <sup>2</sup>	0.040			0.018			0.088		
F	2310.57***			1039.70***			3893.73***		

\*\*\* $p < .01$ , \*\* $p < .05$ , \* $p < .1$

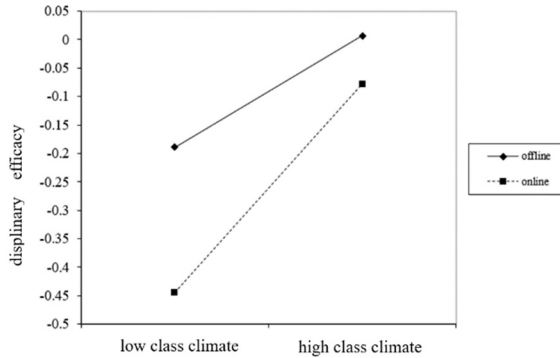
In order to reveal the essence of the interaction effect, a simple slope chart was drawn using the moderating variable 0 as offline and the moderating variable 1 as remote teaching. As shown in Fig. 2, teaching media significantly moderates the predictive effect of classroom environment on self-efficacy. Under distance education, the coefficient of the impact of classroom environment on academic performance is lower than ( $\beta$  Simple=6.459,  $p < 0.001$ ) offline education ( $\beta$  Simple=8.912,  $p < 0.001$ ). This indicates that the classroom environment has a weaker impact on academic performance in distance than in offline.



**Fig. 2.** the moderating effect of teaching medium on class climate and academic achievement

As shown in Figure 3, in offline, the classroom environment has a significant positive predictive effect on subject self-efficacy ( $\beta$  Simple=0.093,  $p < 0.05$ ). Although the

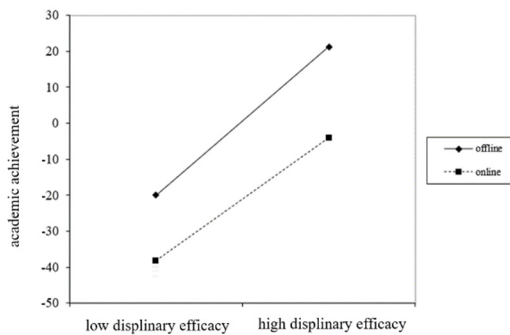
coefficient of the effect of classroom environment on self-efficacy in distance education is higher than that in offline, its effect is not significant ( $\beta_{\text{Simple}}=0.174, p=0.114$ ). This means that the effect of classroom environment on subject self-efficacy in distance is weaker than in offline.



**Fig. 3.** the moderating effect of teaching medium on class climate and disciplinary efficacy

As shown in Figure 4, the coefficient of the effect of subject self-efficacy on academic performance under remote teaching ( $\beta_{\text{Simple}}=17.763, p<0.01$ ) lower than of offline ( $\beta_{\text{Simple}}=21.609, p<0.001$ ). This means that the influence of subject self-efficacy on academic performance in distance education is weaker than in offline.

In summary, the predictive effect of classroom environment on self-efficacy and academic performance in distance education is weaker than that in offline, and the predictive effect of self-efficacy on academic performance is also weaker than that in offline. H4 is valid.



**Fig. 4.** the moderating effect of teaching medium on disciplinary efficacy and academic achievement

## 4 Discussion

This study explores the impact of classroom environment on academic performance through a moderated mediation model, further revealing the mediating role of subject



self-efficacy and the moderating role of teaching media. The research results not only answer how classroom environment affects academic performance, but also the differences in the interaction between classroom environment, subject self-efficacy, and academic performance in distance education and offline. This helps to gain a deeper understanding of the relationship between classroom environment and academic performance, as well as its internal mechanisms of action.

#### **4.1 Positive Prediction of Academic Performance in Classroom Environment**

This study found that classroom environment positively predicts academic performance, which is consistent with previous research. According to Piaget's constructivist theory, humans constantly construct themselves in the process of interacting with the environment. Therefore, a good classroom environment can achieve a positive interaction between people and knowledge. In this process, information transmission is completed, and students can more easily cope with exams, thereby achieving good academic performance.

#### **4.2 The Mediating Role of Self-Efficacy**

This study found that self-efficacy partially mediates the relationship between classroom environment and academic performance. In other words, the impact of classroom environment on academic performance is predicted through a direct pathway, and achieved through the mediating effect of self-efficacy, which is consistent with previous research. In addition, some external factors such as teacher support,<sup>[16]</sup> or internal emotional factors, such as academic anxiety,<sup>[17]</sup> most of them use self-efficacy as a mediator to influence academic performance.

#### **4.3 The Regulatory Role of Teaching Media**

In remote education, the classroom environment, student self-efficacy, and academic performance are generally weaker than in offline. Moreover, the impact of classroom environment on academic performance in distance education is weaker than in offline. This may be due to the current inability of distance education to achieve better classroom interaction than offline, which has been reflected in relevant research in higher education.<sup>[18]</sup> At the same time, the influence of classroom environment on self-efficacy in distance education is significantly weaker than in offline. This may be due to the fact that the quality of classroom environment in current distance education is not as good as in offline, which may lead to students' academic performance relying more on their self-learning ability rather than classroom factors. The positive predictive effect of self-efficacy on academic performance in distance education is also weaker than in offline, which deserves further research.

## 5 Conclusion

(1) After controlling for family background and daily study duration, classroom environment has a significant positive predictive effect on academic performance. (2) Subject self-efficacy partially mediates the relationship between classroom environment and academic performance. (3) The direct effect of classroom environment on academic performance is moderated by teaching media, and the mediating effect of subject self-efficacy is also moderated by teaching media. (4) The predictive effect of classroom environment on self-efficacy and academic performance in distance education is weaker than in offline, and the predictive effect of self-efficacy on academic performance is also weaker than in offline.

## References

1. OECD (2023), PISA 2022 Results (Volume II): Learning During – and From – Disruption, PISA, OECD Publishing, Paris, <https://doi.org/10.1787/a97db61c-en>.
2. Fraser, B.J. (1986) Classroom Environment [M]. London: Room Helm. London: 1~70, 92~119.
3. Liu Hui Research on the Design of Classroom Learning Environment in Primary and Secondary Schools (2021) [J]. Educational Science Research (10), 90-94.
4. Knirk, F.G. (1979) Designing Productive Learning Environments [M]. USA NJ: Educational Technology Publications: 3-7.
5. Fraser, B.J., Treagust, D.F. (1986) Validity and Use of an Instrument for Assessing Classroom Psychosocial Environment in Higher Education [J]. Higher education (1-2): 37-57.
6. Qu Zhiyong (2002) Development Overview of Classroom Environment Research Abroad [J]. Foreign Education Research (07), 21-25
7. Huang Zhifang, Zhou Ruijie, Wan Liyong (2020) Design and Empirical Study of Interactive Classroom Ecosystem in Blended Learning Environment [J]. Research on Electronic Education (04): 78-85.
8. Ding Rui, Ma Yunpeng (2011) Research on the causal relationship between classroom environment and student learning performance: a pre experimental study based on mathematics classrooms [J]. Global Education Outlook (10): 22-29
9. Ding Rui, Huang Yiyi, Ma Yunpeng (2009) The Relationship between Primary School Mathematics Classroom Environment and Students' Problem Solving Ability [J]. Educational Science Research (12): 39-42
10. Fred Russens, Wang Lei, et al (2003) Organizational Behavior [M]. Beijing: People's Posts and Telecommunications Press: 218
11. Tong Xing, Miao Jiandong The Relationship between Subject Self Efficacy and Academic Performance of College Students: The Mediating Role of Learning Optimism [J]. Higher Education Exploration (03): 16-21.
12. Zhang Jianwei, Sun Yanqing (2003) Research on the Efficacy and Related Factors of Distance Learning [J]. Journal of Beijing Normal University (Social Sciences Edition) (04): 68-74.
13. Fu Yu, Qi Chunxia (2023) Research on the Relationship between Teacher Student Relationship and Mathematics Academic Performance: The Mediating Role of Self Efficacy and Mathematics Anxiety [J]. Journal of Mathematics Education (01): 25-30.

14. Yang Hui, Feng Tao (2009) Design of a Distance Learning Support Service Tool for Teachers [J]. *China Distance Education* (02): 64-66
15. Wang Guoqing (2007). Research on self-directed learning guidance strategies in distance education [J]. *China Electronic Education* (09), 33-37.
16. Tan Lihua, Feng Shiji (2024) Teacher autonomy support and primary school students' fearlessness in scientific learning: the mediating role of learning interest and creative efficacy [J]. *Psychological Development and Education* (03): 375-383.
17. Chen Lilan, Wang Yan (2018) The Impact of Mathematical Anxiety on Mathematical Performance of Hearing Impaired Students: The Mediating Role of Mathematical Self Efficacy [J]. *Basic Education* (05): 98-105.
18. Yang Chao, Cheng Baodong, Zheng Yi (2021) Differences in knowledge dissemination effects and influencing mechanisms between on-site and online teaching [J] *Research on Chinese Higher Education* (12): 23-29.

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