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The Relationship between Parental Modelling and Teacher Modelling on Self-Directed Learning Ability among University Students in Shandong, China

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Abstract

This study explores the relationship between the self-directed learning ability of university students in three universities in Shandong Province, China, and the behaviors of their parents and teachers. The aim of this study is to investigate the correlation of parental modelling and teacher modelling on the development of self-directed learning ability among university students, particularly in the academically rich environment of Shandong Province. For this purpose, researchers proposed five research questions and four research hypotheses, employing various statistical methods and utilizing SPSS (version 27) statistical software for data analysis. The results of this study show that parental modelling and teacher modelling are closely related to the change of university students' self-directed learning ability. The results also indicate that self-directed learning ability among university students in Shandong, China is moderate. Age was a significant factor in this regard, while gender was not significant. Furthermore, the findings provide insights for improving self-directed learning ability among university students.

Keywords: Parental Modelling, Teacher Modelling, Self-Directed Learning Ability

Introduction

The research data were obtained from a sample population and analyzed using both descriptive and inferential statistics. In the descriptive part, the study categorized variables by gender and age groups and examined central tendency, dispersion, and distribution indexes. Additionally, tables and graphs were created to present the variables more clearly. This section also included the analysis of research question 1 through the calculation of the mean.

In the inferential statistics section, the research questions and hypotheses were tested using an independent-samples t-test to compare the mean differences in self-directed learning ability between male and female groups (research question 2). Then, one-way ANOVA was used to compare the mean differences in self-directed learning ability among different age groups (research question 3). Furthermore, Pearson correlation was employed to explore the correlation of independent variables, such as parental and teacher behaviors, on university students' self-directed learning ability (research questions 4 and 5).

Descriptive Statistical Analysis

This part presents a description of the demographic profile of the respondents based on the information collected from the questionnaire survey, including the response rate and demographic profile.

Response Rate

From September to November 2024, online questionnaires were distributed to university students in Shandong, China through the Wenjuanxing platform. Wenjuanxing platform is an online research tool integrating questionnaire surveys, examination evaluations, and voting. It mainly provides users with a series of services such as humanized online questionnaire design, data collection, custom reports, and survey result analysis. In the process of investigation, 410 questionnaires were sent to university students of different majors, and a total of 392 valid questionnaires were collected. All 392 questionnaires were complete and valid, with a response rate of 95.6%，and the results are shown in Table Ⅰ below.

Table
Response Rate

Questionnaire Distribution and Collection	Total
Total questionnaire sent	410
Total questionnaire usable	392
Response Rate	95.6%

Demographic Profile

Table Ⅱ demonstrates the frequency distribution of university students by gender and age. From the data, it can be seen that the gender distribution in the study sample was balanced, there were 392 respondents, with the total number of male (gender 1) and female (gender 2) students being equally divided at 196 respectively. Moreover, groups of male and female students aged 19, 20, 21 and 22 were divided into four groups of 49 each. A total of 98 people in each age group. Table Ⅱ shows that the sample distribution of 19 to 22 male and female students age groups is completely consistent. Overall, the sample was more evenly distributed in terms of gender and age group, which aided in subsequent statistical analyses as it reduced bias due to the uneven distribution of the sample.

Table
Frequency distribution of university students by gender and age

Demographic variables	Option	Frequency	Percentage(%)
Gender	Male	196	50%
	Female	196	50%
Age	19	98	25%
	20	98	25%
	21	98	25%
	22	98	25%

Descriptive Statistics of Research Variables

Table Ⅲ demonstrates the distribution of the descriptions of the items of the research questionnaire Self-directed learning ability. According to the table, the mean values of motivation and goal setting in self-directed learning ability questionnaire range from 3.17-3.88. Self-regulation range from 3.33-3.77. Self-efficacy range from 3.19-3.77; Learning strategies range from 3.23-3.52; and self-assessment and reflection had a mean range of 3.40-3.60.

Skewness and kurtosis are two metrics used to measure sample distribution. Skewness determines the extent to which values deviate from the symmetry on either side of the mean. On the other hand, kurtosis assesses the peak or flatness of the distribution (Chapman McGrew & Monroe, 2009). Table Ⅲ shows the skewness and kurtosis results for each variable and question item, respectively.

Table
Description of Each Item of Self-Directed Learning Ability Variable

Variable	Mean	Item	Mean	Std. Deviation	Skewness	Kurtosis
Motivation and Goal Setting	3.46	MAGS1	3.22	1.022	-0.110	-0.420
		MAGS2	3.44	1.078	-0.484	-0.449
		MAGS3	3.27	1.017	-0.092	-0.427
		MAGS4	3.50	0.99	-0.295	-0.463
		MAGS5	3.29	0.923	0.049	-0.623
		MAGS6	3.59	0.892	-0.285	-0.273
		MAGS7	3.88	0.994	-0.925	0.523
		MAGS8	3.17	1.039	-0.039	-0.530
		MAGS9	3.75	0.945	-0.503	-0.298
		MAGS10	3.55	0.966	-0.171	-0.455
Self-Regulation	3.50	SG1	3.33	1.098	-0.124	-0.783
		SG2	3.33	0.962	0.006	-0.703
		SG3	3.42	0.935	-0.271	-0.213
		SG4	3.39	1.053	-0.308	-0.502
		SG5	3.48	0.974	-0.210	-0.612
		SG6	3.45	0.935	-0.367	-0.183
		SG7	3.52	0.91	-0.462	-0.236
		SG8	3.45	0.968	-0.363	-0.504
		SG9	3.55	0.914	-0.126	-0.786
		SG10	3.77	0.836	-0.511	0.203
Self-Efficacy	3.36	SE1	3.58	0.966	-0.198	-0.919
		SE2	3.35	1.058	-0.396	-0.318

Variable	Mean	Item	Mean	Std. Deviation	Skewness	Kurtosis
		SE3	3.27	1.062	-0.323	-0.419
		SE4	3.31	1.025	-0.449	-0.183
		SE5	3.35	0.966	-0.343	-0.226
		SE6	3.36	0.964	-0.392	-0.021
		SE7	3.19	1.059	-0.195	-0.554
		SE8	3.19	1.076	-0.195	-0.568
		SE9	3.55	0.984	-0.711	0.262
		SE10	3.50	1.047	-0.822	0.259
Learning Strategies	3.38	LS1	3.52	0.933	-0.204	-0.615
		LS2	3.52	0.951	-0.738	0.319
		LS3	3.39	1.03	-0.587	-0.155
		LS4	3.40	1.026	-0.610	-0.119
		LS5	3.43	1.065	-0.429	-0.445
		LS6	3.32	1.077	-0.186	-0.662
		LS7	3.23	1.08	-0.249	-0.712
		LS8	3.29	0.99	-0.334	-0.417
		LS9	3.42	0.979	-0.553	-0.172
		LS10	3.27	1.035	-0.290	-0.516
Self-Assessment and Reflection	3.46	SAAR1	3.40	0.984	-0.425	-0.409
		SAAR2	3.44	1.034	-0.243	-0.591
		SAAR3	3.47	1.018	-0.492	-0.333
		SAAR4	3.44	1.008	-0.530	0.005
		SAAR5	3.56	0.926	-0.708	0.302
		SAAR6	3.41	0.953	-0.486	0.030
		SAAR7	3.46	0.998	-0.597	-0.087
		SAAR8	3.60	1.019	-0.629	0.034
		SAAR9	3.44	0.99	-0.353	-0.384
		SAAR10	3.45	0.993	-0.626	0.040

Figure Ⅰ shows the distribution of self-directed learning ability of 392 students with a mean of 3.43 and a standard deviation of 0.678, indicating that most of the students' self-directed learning ability is concentrated around 3.4, the distribution is close to normal, with little individual differences, and with a large sample size, the results are representative.

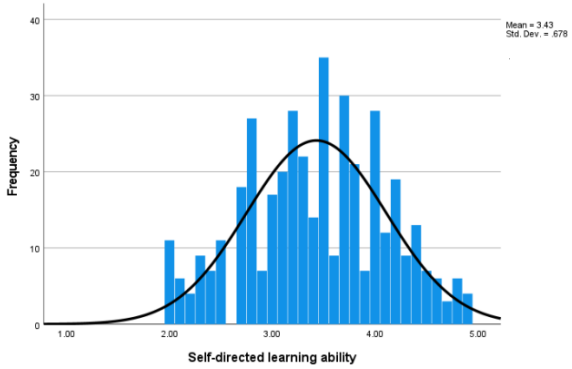

Figure Ⅰ. Frequency Distribution of Self-Directed Learning Ability Variable

Figure Ⅱ shows the self-directed learning ability box-and-line plot, where 1 and 2 represent males and females. The median of self-directed learning ability is close to 3.50 for both gender

groups, but males have a slightly wider inter-quartile range, indicating slightly more variability in their self-directed learning ability. There are no outliers in both groups. Overall, the two groups had similar mean performance on self-directed learning ability, but the distribution was more spread out for the male group.

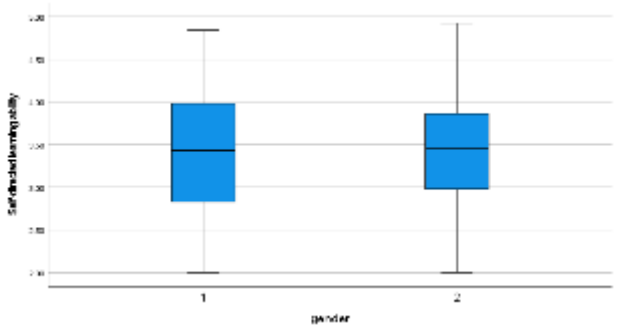

Figure Ⅱ. Distribution of Self-Directed Learning Ability by Gender

Figure Ⅲ is a self-directed learning ability box-and-line plot showing the distribution of self-directed learning ability across four different age groups. Mean Self-directed learning ability scores vary by age group. In contrast, the mean for the 19-year-old group is smaller, and the means for the 20-, 21- and 22-year-old groups are closer, at around 3.50. The narrower inter-quartile ranges for 20 years old indicate a more concentrated distribution of ability across the age. There were no outliers in any of the four age groups.

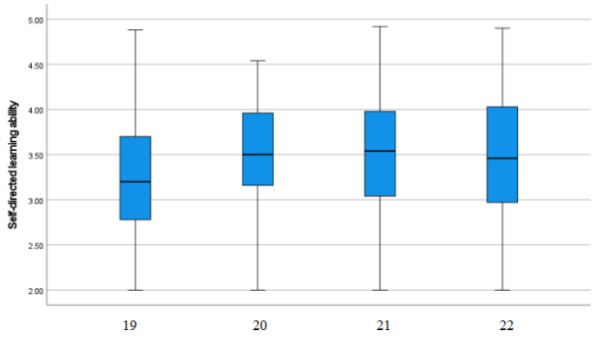

Figure Ⅲ. Distribution of Self-Directed Learning Ability Variable by Age Groups

Table IV demonstrates the distribution of the descriptions of the items of the research questionnaire Parental Modelling. According to the table, the mean values of the items in the Parental Modelling Questionnaire range from 3.86-3.99 for Emotional Support; 3.98-4.07 for Autonomy Support; 3.69-4.06 for Discipline; and 3.8-4.1 for Academic Support; and Role modelling had a mean range of 3.91-4.04. In summary, Parental Modelling scores were high, reflecting the overall good performance of parents in supporting and role modelling their children in all aspects of their lives. In addition, Table IV also shows the skewness and kurtosis results for each variable and question item respectively.

Table IV
Descriptions of the items in the Parental Modelling Variable

Variable	Mean	Item	Mean	Std. Deviation	Skewness	Kurtosis
Emotional Support	3.92	es1	3.86	0.859	-0.654	0.524
		es2	3.94	0.813	-0.706	0.716
		es3	3.9	0.867	-0.749	0.638
		es4	3.93	0.881	-0.95	1.239
		es5	3.88	0.904	-0.764	0.5
		es6	3.95	0.851	-0.812	1.01
		es7	3.99	0.823	-0.727	0.787
Autonomy Support	4.04	as1	4.06	0.785	-0.751	0.95
		as2	4.06	0.798	-0.811	1.155
		as3	4.06	0.754	-0.613	0.493
		as4	4.07	0.805	-1.005	1.917
		as5	3.99	0.856	-1.014	1.635
		as6	4.02	0.789	-0.758	0.99
		as7	3.98	0.856	-0.902	1.157
Discipline	3.88	dp1	3.69	0.963	-0.656	0.274
		dp2	3.69	0.935	-0.554	0.154
		dp3	3.86	0.845	-0.705	0.95
		dp4	3.95	0.774	-0.679	0.97
		dp5	3.98	0.772	-0.759	1.345
		dp6	3.96	0.814	-0.711	0.845
		dp7	4.06	0.748	-0.942	2.115
Academic Support	3.97	ads1	4.01	0.78	-0.735	1.021
		ads2	3.8	0.899	-0.723	0.519
		ads3	3.94	0.857	-0.792	0.913
		ads4	4.03	0.787	-0.846	1.234
		ads5	4.05	0.771	-0.962	2.062
		ads6	3.83	0.886	-0.731	0.649
		ads7	4.1	0.781	-0.923	1.609
Role modelling	3.99	rm1	4.02	0.764	-0.698	1.064
		rm2	3.99	0.838	-1.031	1.871
		rm3	4.04	0.758	-0.716	1.146
		rm4	3.91	0.873	-0.851	1.098
		rm5	4.02	0.786	-0.858	1.596
		rm6	3.95	0.79	-0.632	0.728
		rm7	3.99	0.802	-0.807	1.315

Figure IV is a histogram and normal distribution curve of Parental Modelling showing the distribution of 392 students' ratings of Parental Modelling. The mean is 3.96 and the standard deviation is 0.63, indicating that most of the students' ratings of Parental Modelling are concentrated around 4.00 and the distribution is close to normal. The peak of the histogram appeared at 4.00, with a higher frequency between 3.00 and 5.00, indicating that most students perceived Parental Modelling as positive. At the same time, there are fewer ratings below 2.00 in the histogram, which means that only a few students rated Parental Modelling lower. Overall, the graph shows that students generally perceive Parental Modelling behavior in front of them as positive and the distribution of ratings is more concentrated.

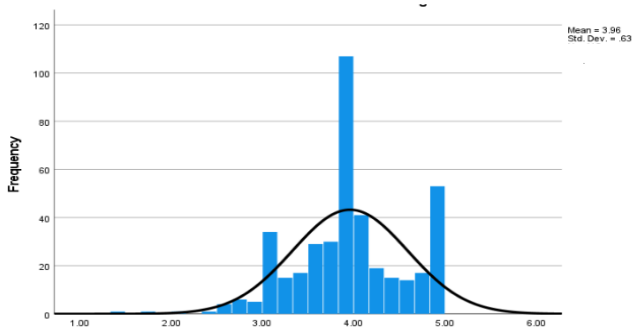

Figure IV. Frequency Distribution of Parental Modelling Variables

Figure V shows the parental modelling box line plot, where 1 and 2 represent males and females. The median of parental modelling is close to 4.00 for both gender groups, but females have a slightly wider inter-quartile range, indicating slightly more variability in their parental modelling. The minimum and maximum values were similar for both groups, with one outlier for males indicating that the individual was well below most males. For the female group on the other hand most of the outliers were below the quartile, which could mean that these students in the female group scored lower on Parental Modelling. Overall, the mean performance on Parental Modelling was similar for both groups, but the distribution was more spread out for the female group.

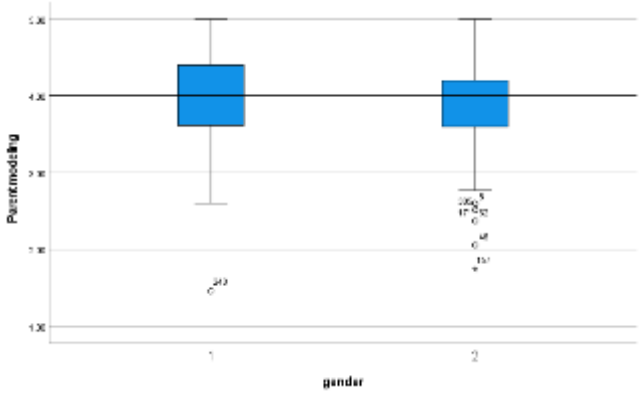

Figure V. Distribution of Parental Modelling Variables on Gender

Figure VI shows the box line plot for parent modelling. The figure shows the distribution across the age groups, where the median for each age is close to or equal to 4.00, indicating that parental modelling behaviors in front of their children are highly rated and relatively consistent across ages.

The wide inter-quartile range for 19 years old and one outlier below 2.00 may mean that in 19 years old, although most university students perceived their parents as good role models, there are some university students who rated them significantly lower than others. The relatively narrow inter-quartile range and fewer outliers in 20 years old suggests that university students in this age have a more focused evaluation of parental role model behaviors. 21 years old also had a narrower inter-quartile range, but there are several outliers, and these values were below 3.00, which may indicate that a small number of university students rated parental role model behaviour lower. 22 years old has a moderate inter-quartile range and no

significant outliers, indicating a more even distribution of ratings among university students in that age.

Overall, with the possible exception of some low ratings in 19 years old, university students in all ages generally perceived their parental modelling in front of them as positive and there were no significant differences in ratings between ages. This may reflect consistency in terms of families across age groups.

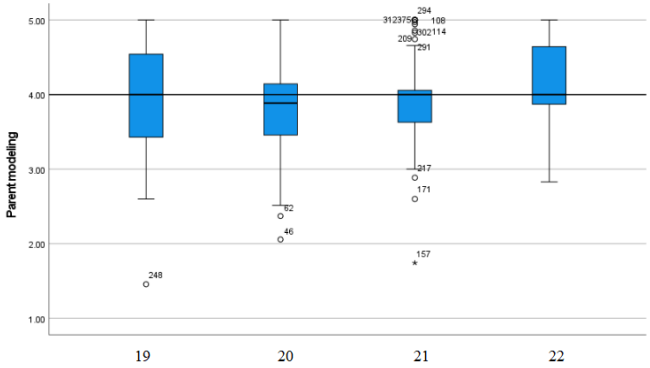

Figure VI . Distribution of Parental Modelling Variables by Age

Table V demonstrates the distribution of the descriptions of the items of the teacher modelling research questionnaire. According to the table, the mean values of the questions in the teacher modelling questionnaire range from 3.97-4.05 for Communication and Instruction; 4-4.07 for Assessment and Feedback; 4-4.07 for Classroom Management; 4-4.09 for Differentiated Instruction; and 4-4.09 for Differentiated Instruction. ranged from 4-4.09; Classroom Relationships ranged from 4.04-4.11; and Professional Development ranged from 4.08-4.1. In addition, The table also shows the skewness and kurtosis results for each variable and question item respectively.

Table V
Description of Each Item of the Teacher Modelling Variable

Variable	Item	Mean	Std. Deviation	Skewness	Kurtosis
Communication and Instruction	cai1	3.97	0.821	-1.137	2.287
	cai2	4.05	0.748	-0.898	1.979
	cai3	4.01	0.814	-1.025	2.006
	cai4	4.1	0.692	-0.539	0.764
	cai5	4.04	0.749	-0.801	1.689
	cai6	4.1	0.729	-0.757	1.536
	cai7	4.02	0.759	-0.605	0.857
Assessment and Feedback	aaf1	4.02	0.78	-0.908	1.803
	aaf2	4.04	0.754	-0.895	2.089
	aaf3	4.03	0.729	-0.623	0.995
	aaf4	4.07	0.715	-0.589	0.985
	aaf5	4.03	0.743	-0.739	1.59
	aaf6	4.05	0.717	-0.629	1.131
	aaf7	4	0.769	-0.648	0.904
Classroom Management	cm1	4	0.8	-0.998	2.093
	cm2	4.06	0.738	-0.754	1.47

Variable	Item	Mean	Std. Deviation	Skewness	Kurtosis
	cm3	4.04	0.767	-1.043	2.513
	cm4	4.05	0.761	-0.927	2.081
	cm5	4.06	0.775	-1.015	2.323
	cm6	4.07	0.716	-0.75	1.712
	cm7	4.09	0.731	-0.863	2.069
Differentiated Instruction	di1	4.01	0.774	-0.721	1.042
	di2	4	0.76	-0.631	0.956
	di3	4.01	0.775	-0.816	1.609
	di4	4.08	0.707	-0.4	-0.036
	di5	4.03	0.765	-0.683	0.995
	di6	4.06	0.705	-0.632	1.253
	di7	4.01	0.775	-0.617	0.754
Classroom Relationship	cr1	4.04	0.781	-0.935	1.863
	cr2	4.07	0.774	-0.886	1.619
	cr3	4.09	0.702	-0.51	0.581
	cr4	4.09	0.679	-0.493	0.781
	cr5	4.1	0.686	-0.457	0.534
	cr6	4.09	0.723	-0.645	0.817
	cr7	4.11	0.726	-0.9	2.039
Professional Development	pd1	4.09	0.739	-0.728	1.121
	pd2	4.1	0.706	-0.475	0.155
	pd3	4.1	0.696	-0.571	0.841
	pd4	4.09	0.745	-0.75	1.138
	pd5	4.1	0.749	-0.695	0.882
	pd6	4.1	0.699	-0.618	1.209
	pd7	4.08	0.738	-0.854	1.763

Figure VII is a histogram of teacher modelling combined with a normal distribution curve showing the distribution of 392 students' ratings of teacher modelling. The mean is 4.06 and the standard deviation is 0.591, indicating that the majority of the students' ratings of teacher modelling are clustered around 4.00 and the distribution is close to normal. The peak of the histogram appears at 4.00 and has a high frequency between 3.00 and 5.00, indicating that most students perceive teacher modelling as positive. At the same time, the graph shows fewer ratings below 2.00, which could mean that only a few students rated Teacher Modelling low. Overall, this graph shows that students generally perceive teacher modelling behaviour in front of them as positive and the distribution of ratings is more concentrated.

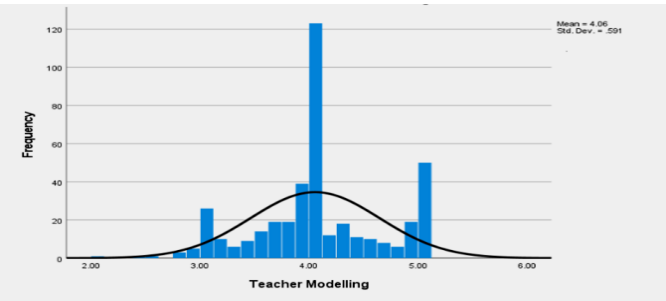

Figure VII. Frequency Distribution of Teacher Modelling Variables

Figure VIII shows a box line plot of teacher modelling where 1 and 2 represent male and

female. As can be seen from the graph, the median for both gender groups is close to 4.00, indicating that both groups of university students rated teacher modelling similarly. The wider inter-quartile range for males implies that the distribution of evaluations for this group of university students is more spread out, while the narrower inter-quartile range for females suggests that evaluations are more concentrated. Males have one outlier below 2.50, whereas females have multiple outliers, and these values are below 3.00, possibly indicating that a subset of university students in females rated teacher modelling significantly lower than others. Overall, although the two groups have similar mean ratings on teacher modelling, the female university students show greater individual differences in their ratings.

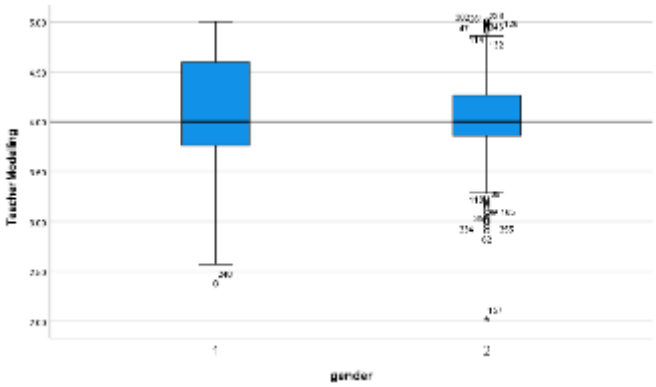

Figure VIII. Distribution of Teacher Modelling Variables by Gender

Figure IX shows a box line plot of the teacher modelling ratings. The graph shows the distribution across the four age groups, where the median for each age is close to or slightly above 4.00, indicating that teacher modelling behaviors in front of university students are highly rated by students at all age groups.

The wide inter-quartile range for 19-year-old group and no prominent outliers mean that among this age group, evaluations of teacher modelling are spread over a larger range but without extreme deviations. The inter-quartile range for 20-year-old is relatively narrower, yet there are several outliers (all below 3.00), suggesting some students in this age group rate teacher modelling significantly lower. For 21-year-old, the inter-quartile range is moderate, but there are numerous and extreme outliers (including a very extreme one near 2.00), indicating that quite a few students in this age group rate teacher modelling much lower. 22-year-old have a wide inte-quartile range (similar to 19-year-old) and no significant outliers, implying their evaluations of teacher modelling are spread out but without extreme values.

Overall, while all age groups show a central tendency around 4.0 for teacher modelling, there are distribution differences: 19 and 22-year-old groups have wider ranges without extreme outliers, while 20 and especially 21-year-old groups have some lower outliers. Despite these variations, the consistent central tendency may reflect the school's uniformity in teacher role - model behaviour across age groups.

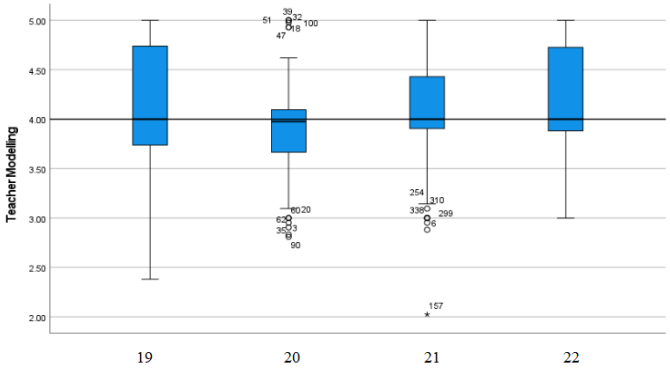

Figure IX Distribution of Teacher Modelling Variables by Age

Statistical Analysis and Research Findings

This part of the study focus on the analysis of the research questions and research hypotheses, but before that, to ensure that there were no input errors when entering the data, the minimum and maximum values of the study variables were first tested. The results showed that the number of the lowest and highest study variables is no greater than or less than the above range of the relevant questionnaire. Therefore, no typing errors had occurred.

Research Question 1 (RQ1) :

In this section, research question 1 is discussed as follows:

RQ1:What is the current status of self-directed learning ability among university students in Shandong, China?

Research question 1 is answered by determining whether the current status of self-directed learning ability is low, medium, or high. In addition, a descriptive survey is conducted by calculating the mean value of the variable.

The results show that the mean value of self-directed learning ability is 3.43. According to the average, 44.5% of university students score below average on their self-directed learning ability. To interpret the mean and determine whether the level of self-directed learning ability is low, medium, or high, the study benefits from a technique proposed by Green, Salkind, and Akey (1997) for classifying the mean scores into three categories: low, medium, and high. To this end, participants rate their choices in self-directed learning ability ranging from 1 to 5 point according to Richter Scale, with three parts: low, medium, and high. The following Figure.

shows the process.

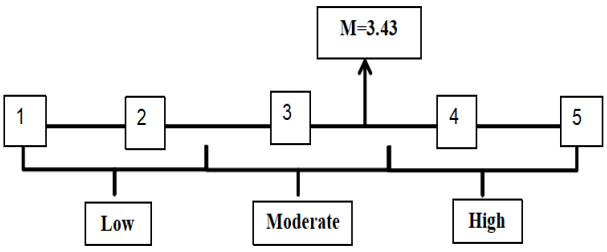

Figure X Determining the range of scores for low, moderate and high for SDLA

The figure above shows that there is a space between each number from 1 to 5, for a total of 4 spaces. These Spaces are divided into three categories, the scope of each of which is shown in the table below. An average score of 1-2.33 indicates that university students have a low

degree of self-directed learning ability, while an average score of 2.34-3.66 indicates that university students have a moderate degree of self-directed learning ability. Finally, the average score is between 3.67 and 5, indicating a high self-directed learning ability of university students.

As for the mean value of self-directed learning ability (mean=3.43), according to the following table, it can be concluded that the current status of self-directed learning ability among university students in Shandong, China, is moderate.

Table VI Indicator of Mean Scores for the Current Status of SDLA

Range	Indicator
1 to 2.33	Low
2.34 to 3.66	Moderate
3.67 to 5	High

Research Question 2 (RQ2) and Hypothesis (H1)

This section will discuss research question 2 and hypothesis 1 of the study as follows:

RQ2:What is the difference in self-directed learning ability between male and female among university students in Shandong, China?

H1: There is a significant difference in the self-directed learning ability among male and female university students in Shandong, China.

To explore research question 2 and determine the differences between male and female university students in self-directed learning ability, an independent sample T-test was used. These results are shown in the following.

Table VI

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Self-Directed Learning Ability	female	196	3.42	0.719	0.052
	male	196	3.43	0.642	0.043

According to above table, there are 196 females and 196 males in the female group and the mean score of self-directed learning ability of female is 3.42, while the mean score of self-directed learning ability of male is 3.43.

The following table provides the results of the analysis of difference of male and female university students in self-directed learning ability. Firstly, Levene's test was used to test whether the variances of the two groups of data were equal or not, and the result showed that the F-value was 4.288, which corresponded to a level of significance (Sig.) of 0.039, which was lower than the usual level of significance of 0.05, suggesting that the two groups of data did not have equal variances, i.e., there was a lack of homogeneity of variance. Next, a t-test was conducted to compare the means of the two groups for significant differences. Under the assumption of equal variance, the t-value was -0.117, the degree of freedom (df) was 408, and the corresponding two-tailed significance level (Sig. (2-tailed)) was 0.907, which is much higher than 0.05 (P>0.05), indicating that there is no significant difference between the means of Self-directed learning ability of the two groups. Without assuming equality of variances, the t-value

is -0.116 with a degree of freedom of 385.893, corresponding to the same two-tailed significance level of 0.908, which is consistent with the results, indicating that there is no statistically significant difference between the two groups. The Mean Difference was -0.00786, Std. Error Difference was 0.0677, and the 95% Confidence Interval of the Difference had a lower limit of -0.14097 and an upper limit of 0.12525, which contained 0. This further confirms that the difference in means between the two groups is not significant. These results indicate that there is no statistically significant difference between the two groups in terms of their performance on Self-directed learning ability, whether or not variance in-homogeneity is taken into account. Hence, the H2 is rejected.

Table VIII

Analysis of Differences of Male and Female University Students in Self-Directed Learning Ability

		Levene's Test for Equality of Variances		T-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SDLA	Equal variances assumed	4.288	0.039	-0.117	408	0.907	-0.00786	0.06722	-0.13999	0.12428
	Equal variances not assumed			-0.116	385.893	0.908	-0.00786	0.0677	-0.14097	0.12525

In this regard, the following figure shows the error line plot of the variance on self-directed learning ability. The graph shows the mean self-directed learning ability for both gender groups, with males having a mean of 3.42 and females having a mean of 3.43. The error lines indicate the variability or uncertainty in the data for each gender group, and as can be seen from the graph, the error lines are of similar length for both gender groups, indicating that the variability is similar for both groups.

Although the mean for females is slightly higher than that for males, the difference between the two groups is very small and, given the overlap of the error lines, this difference may not be statistically significant. This suggests that there may not be a significant gender difference between men and women in self-directed learning ability. Based on the results of the previous analyses, we know that the difference between the two groups is not statistically significant (Sig. (2-tailed) = 0.907 and 0.908). Hence, H1 is rejected.

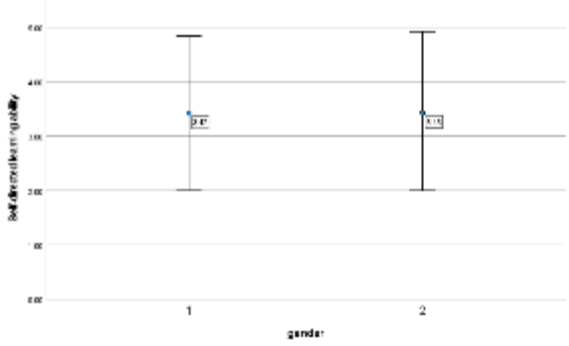

Figure XI Mean Difference in Self-Directed Learning Ability by Gender

Research Question 3 (RQ3) and Hypothesis (H2)

This section will discuss research question 3 and associated hypothesis 2 of the study as follows:

RQ3: What is the difference in self-directed learning ability of different age groups among university students in Shandong, China?

H2：There is a significant difference in the self-directed learning ability among different age groups of university students in Shandong, China.

To test research question 3 and determine the relationship between the average values of different age groups and their autonomous learning ability, one-way analysis of variance was adopted. In this case, the estimates are as shown in following table.

Among them, the average score of self-directed learning ability in the 19-year-old group was 3.237 points, which was much lower than the average score of other age groups. The average score of the 20-year-old age group was 3.505, which was much higher than that of other age groups. The average scores of the 21-year-old and 22-year-old age groups were similar, being 3.332 and 3.486 respectively.

The following table presents the results of one-way analysis of variance for self-directed learning ability in different age groups. Firstly, Levene's Test was used to examine whether the variations of data among different age groups were equal. The Levene statistic was 2.537, corresponding to a significance level (Sig.) of 0.056, which was higher than the usual significance level of 0.05 (P>0.05). The results indicated that the variations of self-directed learning ability among different age groups were homogeneous.

Thus, the F-test will be conducted to compare whether there are significant differences in the means of self-directed learning ability among the four age groups next. The results show that the F value of the mean equality test is 3.661, the degree of freedom (df1) is 3, the degree of freedom (df2) is 406, and the corresponding significance level (Sig.) is 0.001, which is lower than 0.05. This indicates that there are significant differences in self-directed learning ability among the four age groups (F=3.661, P<0.05).

Table IX

Results of One-Way ANOVA to Examine the Difference in Self-Directed Learning Ability by Age Groups

Descriptive				ANOVA					
Age Groups	N	Mean	Std. Deviation	Tests of Homogeneity of Variances		Test of Equality of Means			
				Levene Statistic	Sig.	df1	df2	F	Sig.
19	98	3.237	0.6295	2.537	0.056	3	406	3.661	0.001
20	98	3.505	0.6061						
21	98	3.332	0.66217						
22	98	3.486	0.77508						

The following table presents the results of the LSD post-hoc test for differences in self-directed learning ability across different age groups. The analysis reveals that there are statistically significant differences in self-directed learning ability between all pairs of age groups (all Sig. = 0), and the 95% confidence intervals of the mean differences (I-J) do not contain 0, further verifying the reliability of the significant differences. Specifically, the self-

directed learning ability of the 19-year-old group is significantly lower than that of the 20-year-old group (mean difference = -0.268), 21-year-old group (mean difference = -0.095), and 22-year-old group (mean difference = -0.249); the 20-year-old group shows significantly higher self-directed learning ability than the 19-year-old group (mean difference = 0.268), 21-year-old group (mean difference = 0.173), and 22-year-old group (mean difference = 0.019); the 21-year-old group has significantly higher self-directed learning ability than the 19-year-old group (mean difference = 0.095) but significantly lower than the 20-year-old group (mean difference = -0.173) and 22-year-old group (mean difference = -0.154); the 22-year-old group exhibits significantly higher self-directed learning ability than the 19-year-old group (mean difference = 0.249) and 21-year-old group (mean difference = 0.154) but significantly lower than the 20-year-old group (mean difference = -0.019). Hence, H2 is accepted.

Table X
LSD Test for Differences in Self-Directed Learning Ability by Age Groups

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
19	20	-.268000*	0	0	-0.268	-0.268
	21	-.095000*	0	0	-0.095	-0.095
	22	-.249000*	0	0	-0.249	-0.249
20	19	.268000*	0	0	0.268	0.268
	21	.173000*	0	0	0.173	0.173
	22	.019000*	0	0	0.019	0.019
21	19	.095000*	0	0	0.095	0.095
	20	-.173000*	0	0	-0.173	-0.173
	22	-.154000*	0	0	-0.154	-0.154
22	19	.249000*	0	0	0.249	0.249
	20	-.019000*	0	0	-0.019	-0.019
	21	.154000*	0	0	0.154	0.154

Research Question 4 (RQ4) and Hypothesis (H3)

In this section, research question 4 and the associated hypothesis 3 are tested as follows:

RQ4: What is the relationship between parental modelling and self-directed learning ability among university students in Shandong, China?

H3: There is a significantly positive relationship between parental modelling and self-directed learning ability among university students in Shandong, China.

Regarding research question 4, the participants answered a total of 85 questions; of these, 35 questions rated 1-5 point (Richter scale), related to parental modelling (IV), and 50 questions rated 1-5 point (Richter scale), related to overall self-directed learning ability. In order to perceive the variance of DV (self-directed learning ability) by the IV (parental modelling), Pearson correlation analysis was used and the related hypothesis is also tested. By calculating the Pearson correlation coefficient, this study quantified the degree of correlation between variables and determined which factors were interrelated to some extent (Lu wen ting *et.al.*, 2025).

The following table presents the results of the Pearson correlation analysis between the components of Parental Modelling and Self-directed learning ability. The significance level

(Sig.) for all correlations is 0.001, which is much lower than 0.05, indicating that these correlations are statistically significant. These positive correlation coefficients indicate that positive parental behaviour in these areas is significantly and positively correlated with university students' self-directed learning ability. Of these, academic support had the strongest correlation with self-directed learning ability (r=0.729), followed by role modelling and discipline, which may mean that the behaviour of giving support and acting as a role model in academic activities has a particularly significant significance on university students' self-directed learning ability.

Table XI

Pearson Correlation Analysis Between Parental Modelling and Self-Directed Learning Ability

Correlations					
Pearson Correlation	Emotional Support	Autonomy Support	Discipline	Academic Support	Role modelling
Self-Directed Learning Ability	0.696	0.674	0.701	0.729	0.704
Sig. (1-tailed)	0.001	0.001	0.001	0.001	0.001
N	392	392	392	392	392

The following figure also illustrates the correlation relationships. The results show that all support behaviors are significantly positively correlated with self-directed learning ability (r ranging from 0.674 to 0.729, $p < 0.001$), with “academic support” having the highest correlation (r = 0.729), followed by “role modelling” (r = 0.704). As teachers' scores for various support behaviors increase, students' scores for self-directed learning ability also rise accordingly. The scatter plot shows a tight linear distribution toward the upper right, indicating that the more emotional, autonomy, disciplinary, academic, and role model support teachers provide, the stronger students' self-directed learning ability becomes.

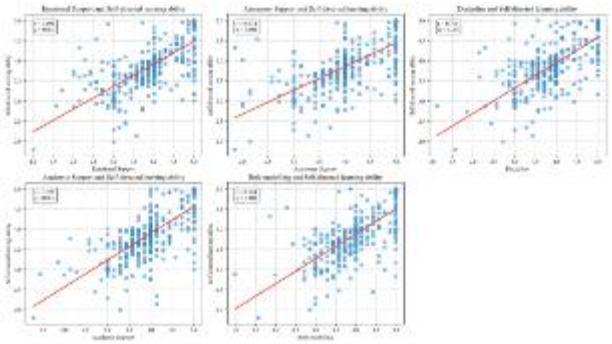

Figure XII Scatter Plot Showing the Correlation Between Parental Modelling and Self-Directed Learning Ability

Overall, these results highlight the importance of different aspects of parental support and behaviour on the development of university students' self-directed learning ability. Hence, H3 is accepted.

Research Question 5 (RQ5) and Hypothesis (H4)

In this section, research question 5 and the associated hypothesis 4 are tested as follows:

RQ5: What is the relationship between teacher modelling and self-directed learning ability among university students in Shandong, China?

H4: There is a significantly positive relationship between teacher modelling and self-

directed learning ability among university students in Shandong, China.

Regarding research question 5, participants answered 42 questions with answers ranging from 1 to 5 point on a Richter scale. For the analysis of participants and the prediction of variance in the DV (self-directed learning ability) by the IV (teacher modelling constructs), Pearson correlation analysis was used.

The following table presents the results of the Pearson correlation analysis between aspects of Teacher Modelling and Self-directed learning ability. The significance level (Sig.) for all correlations is 0.001, which is much lower than 0.05, indicating that these correlations are statistically significant.

Table XII

Pearson Correlation Analysis Between Teacher Modelling And Self-Directed Learning Ability

Correlations						
Pearson Correlation	Communication and Instruction	Assessment and Feedback	Classroom Management	Differentiated Instruction	Classroom Relationship	Professional Development
SDLA	0.708	0.689	0.655	0.666	0.668	0.673
Sig. (1-tailed)	0.001	0.001	0.001	0.001	0.001	0.001
N	392	392	392	392	392	392

Specifically, communication and instruction has the highest correlation coefficient of 0.708 with self-directed learning ability, indicating that this aspect has a very strong positive correlation with the improvement of university students' self-directed learning ability. All these positive correlation coefficients all indicate that positive teacher behaviour in these areas are significantly and positively correlated with the improvement of university students' self-directed learning ability.

The following figure also illustrates the correlation relationships. The results show that all six domains of teacher modelling are significantly positively correlated with self-directed learning ability (r values ranging from 0.655 to 0.722, $p < 0.001$), with “communication and instruction” showing the strongest correlation ($r = 0.708$), followed by “classroom relationships” ($r = 0.673$). As scores for each teaching practice increased, students' self-directed learning ability scores also rose accordingly, with the scatter plot showing an overall upward-sloping linear trend. This indicates that the higher the teachers' investment in these teaching practices, the stronger the students' self-directed learning ability.

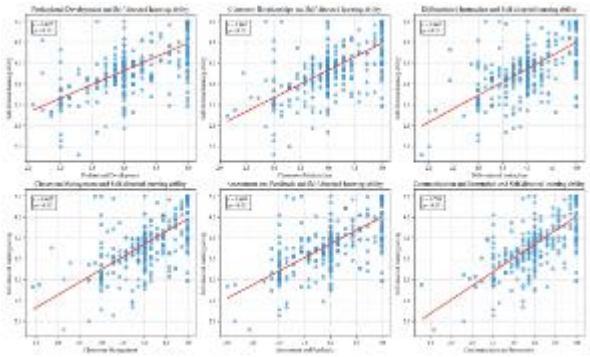

Figure XIII Scatter Plot Showing the Correlation Between Teacher Modelling and Self-Directed Learning Ability

Overall, these results emphasize the importance of teachers' role modelling behaviour in different aspects for the development of university students' self-directed learning ability. In particular, the aspect of communication and instruction has the strongest correlation with self-directed learning competence, which may imply that effective teacher communication and guidance during the teaching and learning process is particularly crucial for the enhancement of university students' self-directed learning ability. Hence, H4 is accepted.

Research Questions Discussion and Hypothesis Testing

Data analysis shows that the self-directed learning ability of university students in Shandong, China, is at a moderate level, and there is still a certain gap compared with the current high-level demand for self-directed learning ability. This reflects that university students face many challenges in the process of cultivating and improving self-directed learning ability, especially in terms of the parental modelling and teacher modelling. The results of this study are summarized in following tables.

The Summary of Research Questions and Findings

Research questions	Results
RQ1: What is the current status of self-directed learning ability among university students in Shandong, China?	The self-directed learning ability among university students in Shandong, China is moderate.
RQ2: What is the difference in self-directed learning ability between male and female among university students in Shandong, China?	There is not a significant difference in the self-directed learning ability among male and female university students in Shandong, China.
RQ3: What is the difference in self-directed learning ability of different age groups among university students in Shandong, China?	There is a significant difference in the self-directed learning ability among different age groups of university students in Shandong, China.
RQ4: What is the relationship between parental modelling and self-directed learning ability among university students in Shandong, China?	There is a significantly positive relationship between parental modelling and self-directed learning ability among university students in Shandong, China.
RQ5: What is the relationship between teacher modelling and self-directed learning ability among university students in Shandong, China?	There is a significantly positive relationship between teacher modelling and self-directed learning ability among university students in Shandong,China.

The research results show that self-directed learning ability is closely related to demographic factors such as age, as well as the parental modelling and teacher modeling. Understanding these relationships is crucial for formulating strategies to enhance university students' academic self-efficacy and cultivate their self-directed learning ability.

The Hypothesis Test Result

Hypotheses	Results
H1: There is a significant difference in the self-directed learning ability among male and female university students in Shandong, China.	Rejected
H2: There is a significant difference in the self-directed learning ability among different age groups of university students in Shandong, China.	Accepted
H3: There is a significantly positive relationship between parental modelling and self-directed learning ability among university students in Shandong, China.	Accepted
H4: There is a significantly positive relationship between teacher modelling and self-directed learning ability among university students in Shandong, China.	Accepted

These results confirm that there is considerable space for improvement in university students' self-directed learning ability, and it varies with age. Furthermore, the positive relationship between the parental modelling, the teacher modelling and self-directed learning ability emphasizes the importance of parents providing appropriate academic and emotional support, as well as a tolerant and harmonious classroom atmosphere to enhance university students' self-directed learning ability.

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