International Journal for Housing Science and Its Applications
Publish August 5, 2025. Volume 46, Issue 3 Pages 4076-4084

https://doi.org/10.70517/ijhsa463347

Regression model-based analysis of gender differences in preschool education and assessment of the effectiveness of educational approaches

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Abstract This paper uses a questionnaire to quantitatively analyze the cognitive development, social development and study habits of 350 kindergarten students. Combining the independent samples t-test with multiple stepwise regression modeling, it explores the effects of gender, school segment and education mode on the effectiveness of preschool education. The estimation of unknown coefficients was obtained using the great likelihood method, and regression model averages were established. It was found that girls outperformed boys in the three dimensions of cognitive development, social development, and study habits, with p-values of 0.015, 0.026, and 0.001, respectively, with the greatest difference in study habits (t = -3.018, p = 0.001). Among the educational styles, verbal expression (β=0.153, p=0.033) and logical thinking (β=0.114, p=0.002) showed a significant positive effect, cooperation (β=0.133, p=0.023) had a practical preference for the actual contribution of preschool education effects, and learning strategies (β=0.612, p=0.003) were the most significant predictive variables. The results of the study provide empirical evidence for optimizing preschool education practices and reducing gender differences.

Index Terms preschool education effectiveness assessment, multiple stepwise regression model, model mean, independent samples t-test, gender difference analysis

I. Introduction

As an important aspect of gender inequality, educational inequality between the sexes has been the subject of sustained attention by social stratification researchers, and gender equality education is also an important development in the current education system [1], [2]. Preschool children are the key period of gender socialization, and gender differences in preschool education have obvious traces in preschool education, which are manifested in gender stereotypes, unequal responsibility tasks and interest cultivation bias [3]-[5]. As China's high-quality education continues to advance, the high-quality development of preschool education has also attracted much attention. It is an extremely important task for early childhood teachers to utilize a gender-based perspective in their teaching and learning activities in order to develop a good personality trait in young children [6], [7].

Female teachers tend to make children more likely to acquire personality traits such as meticulousness and patience, while male teachers are more likely to give children personality traits such as courage, calmness, independence, boldness and adventurousness [8]-[10]. However, in today's kindergarten teachers, women account for a larger proportion, the influence of female personality traits is much more dominant than that of men, resulting in a variety of negative impacts such as stereotypes of young children's perceptions of gender, the existence of gender stereotypes in teachers themselves, and the type of kindergarten activities are more conservative and other negative impacts [11]-[14]. Therefore, the analysis of gender differences and teaching effects in preschool education will be conducive to optimizing the gender structure of kindergarten teachers, which has certain inspiration and significance in promoting the high-quality development of preschool education.

This paper firstly introduces the research object and the source of research data, and relies on Cronbach's Alpha coefficient and exploratory factor analysis to test the validity of the questionnaire. A multiple regression model was used to start the study, and the model averaging method was introduced to improve the prediction accuracy. The independent sample t-test method was selected to analyze the influence of demographic variables on the effectiveness of preschool education. Regression equations were used to test the influence relationship between independent variables and dependent variables to assess the effect of different preschool education methods.

II. Regression modeling-based research design for preschool education for kindergarten students

As an important stage of basic education, preschool education has a profound impact on children's cognitive ability, social development and the formation of learning habits. Existing research lacks systematic empirical analysis of the specific role mechanisms of gender factors in the effects of preschool education, while quantitative research on educational styles is relatively insufficient. Based on the perspectives of educational equity and individual development, this study combines psychological and sociological theories to construct a regression model, aiming at revealing the distribution characteristics of gender differences in preschool education and evaluating the actual effects of different educational approaches.

II. A. Subjects of study

A total of 350 kindergarten level students were surveyed, 362 questionnaires were distributed, and 360 questionnaires were recovered with a recovery rate of 99.45%. Of the recovered questionnaires, 10 were rejected, with an efficiency rate of 97.22%. The ratio of gender and school section is relatively balanced, the survey respondents are from rural and non-rural areas, and the type of preschool gardens is higher in public than in private gardens, and the specific information of the research subjects is shown in Table 1.

Table 1: Sample Situation Analysis(N=397)

Project	Option	Number of people	Percentage/%
Gender	Male	188	53.71%
	Female	162	46.29%
Educational stage	Lower grades(Little class)	68	19.43%
	Middle Section(Middle class)	170	48.57%
	Senior Grade(Upper class)	112	32.00%
Native place	Rural	155	44.29%
	Non-rural	195	55.71%
Kindergarten type	Public	182	52.00%
	civilian-run	168	48.00%

II. B. Data sources

This study mainly used a combination of questionnaire survey and interview method to collect data, in which the questionnaire was targeted at kindergarten students. Interviews were conducted with school leaders, teachers, students and parents. The implementation period is from September 2024 to October 2024.

First, survey data collection. This paper analyzes the effect of preschool education from three dimensions: cognitive development, social development, and study habits, setting a total of 13 questions from A6 to A18, and adopting a 5-point Likert scale: 1-not at all; 2-not very much; 3-unsure; 4-comparatively; 5-completely. The main structure of the questionnaire is shown in Table 2.

Table 2: Introduction of the main structure of the questionnaire

Main dimension	Question type	Item
Student basic information	Single Choice Question	A1~A4
Implementation of preschool education for students	Single Choice Question	A5
Cognitive development	Single Choice Question	A6~A10
Social development	Single Choice Question	A11~A14
Study habit	Single Choice Question	A15~A18
Satisfaction with preschool education	Single Choice Question	A19
Student suggestion	Single choice question,subjective question	A20

The results of the reliability test in this study about the preschool education effectiveness survey are good.

Internal consistency reliability test. The results of the scale Alpha coefficient test are shown in Table 3. The Cronbach's Alpha coefficient calculated using SPSS software is 0.931.Generally, Cronbach's Alpha coefficient is required to be greater than 0.7, and the coefficient of this scale exceeds 0.9, which indicates that the internal consistency reliability of this scale is good. In addition, specifically analyzing the Cronbach Alpha coefficient after deleting each item, it can be learned that each item of this scale reflects a consistent concept, and it can be considered that this scale has a good internal consistency reliability.

Table 3: The clone Bach Alpha coefficient test of the questionnaire

Item	The average scale value after deleting the item	The scale variance after deleting the item	The revised items are correlated with the total	Square multiple correlation	The clone Bach Alpha after deleting the item
A6	61.251	141.532	0.623	0.617	0.931
A7	60.933	141.717	0.618	0.592	0.927
A8	61.465	141.258	0.652	0.668	0.927
A9	60.882	142.083	0.603	0.579	0.932
A10	61.251	141.225	0.594	0.603	0.932
A11	62.074	141.785	0.617	0.588	0.924
A12	61.686	142.123	0.583	0.621	0.925
A13	62.752	141.856	0.621	0.605	0.925
A14	61.441	142.008	0.575	0.593	0.928
A15	60.522	141.239	0.611	0.627	0.931
A16	61.765	142.053	0.626	0.493	0.927
A17	61.331	141.228	0.618	0.575	0.927
A18	60.873	142.863	0.597	0.582	0.931

Structural validity test. In this study, exploratory factor analysis was used to conduct structural validity test, firstly, the data were subjected to KMO coefficients and Bartlett's spherical test, and then the questionnaire was subjected to exploratory factor analysis using principal component factor analysis and maximum variance rotation, so as to establish the independent latent factors, and the KMO value was 0.926, and the Bartlett's spherical test was significant, which indicated that it was suitable to conduct factor analysis, and subsequently After several factor rotation analyses and entry selection, three factors were finally retained, and the eigenvalues of each entry are shown in Table 4. The results from the exploratory factor analysis were inconsistent with what we expected, and for further analysis, the scale was then tested for content validity.

Table 4: Structural Validity test of the questionnaire

Item	Component		
	1	2	3
A17	0.862		
A18	0.817		
A9	0.768		
A10	0.669		
A6	0.583		
A14		0.836	
A15		0.775	
A16		0.693	
A12		0.588	
A13			0.822
A7			0.781
A8			0.705
A11			0.638

Content validity test. This paper invites experts who have been studying preschool education for a long time to score, synthesizes the opinions of all the experts, and makes several revisions to form the preschool education effect questionnaire in this paper. The preschool education effect scale for kindergarten students includes a total of 3 major factors: cognitive development, social development and study habits.

II. C.Research methodology

The log odds ratio of traditional multiple logistic regression is fitted with a linear model, but the use of a linear model alone may ignore the influence of nonlinear factors, so based on traditional multiple logistic regression, a partially linear model is taken to fit the log odds ratio, and a partially linear multiple logistic regression model is constructed, i.e.

$$\mu_{ij} = \log \frac{p_{ij}}{p_{i1}} = \xi_j(X_{it}) + X_{i\backslash t}^{\bullet}\alpha_j, i = 1,\dots,n, j = 2,\dots,J, \tag{1}$$

where $\xi_j(\cdot)$ is a one-dimensional unknown continuous function with second-order derivatives present; since any continuous-type covariate can be used as the independent variable of the function $\xi_j(\cdot)$ without loss of generality, let $t \in T$, T be the set of indicators consisting of all the continuous-type covariates, and satisfy $|T| = d \le p$. That is, the number of continuous covariates is assumed to be d; α_j is a $p-1$ dimensional vector of unknown coefficients, and $X_{i\backslash t}$ is a $p-1$ dimensional vector excluding the t th covariate. The above partially linear model is more flexible than traditional multivariate logistic regression to characterize the nonlinear relationship between the covariates and the log odds ratio μ_{ij}. Under this model, for a given X_i, the conditional probability of $Y_i = j$ can be expressed as

$$\begin{cases} p_{i1} = \Pr\{Y_i = 1 \mid X_i\} = \dfrac{1}{1 + \sum_{l=2}^{J} \exp(\mu_{il})}, \\ p_{ij} = \Pr\{Y_i = j \mid X_i\} = \dfrac{\exp(\mu_{ij})}{1 + \sum_{l=2}^{J} \exp(\mu_{il})}, i = 1,\dots,n, j = 2,\dots,J \end{cases} \tag{2}$$

In order to improve the prediction effect of the model, the above model is chosen as a candidate model for model averaging, i.e., the s th candidate model is assumed to be:

$$\mathrm{M}_s : \mu_{ij}^{(s)} = \log \frac{p_{ij}^{(s)}}{p_{i1}^{(s)}} = \xi_j^{(s)}(X_{is}) + X_{i\backslash s}^{\bullet}\alpha_j^{(s)}, j = 2,\dots,J, s = 1,\dots,d \tag{3}$$

where $X_{i\backslash s} = (X_{i1},\dots,X_{i,s-1},X_{i,s+1},\dots,X_{ip})^{\bullet}$. In this paper, d non-nested candidate models can be constructed by rotating each continuous-type independent variable as the independent variable of the non-parametric component of the partially linear model, and the advantage of constructing this type of candidate model is that the information can be extracted sufficiently and is not duplicated. Unlike the nested type of model averaging, if a nested model is chosen as a candidate model when $n \to \infty$, the weight of the largest candidate model will asymptotically go to 1 in the least squares model averaging process when all candidate models are underfitted.

In this paper, the following approach will be taken to estimate the nonparameters and parameters separately. Based on the above candidate model definition, $\xi_j^{(s)}(\cdot)$ in the candidate model (3) will be estimated first. The estimation of the unknown function $\xi_j^{(s)}(\cdot)$ in the candidate model is done by the local partial likelihood method. The first-order Taylor expansion of $\xi_j^{(s)}(X_{is})$ at x_0 is performed

$$\xi_j^{(s)}(X_{is}) \approx \xi_j^{(s)}(x_0) + \dot{\xi}_j^{(s)}(x_0)(X_{is} - x_0) \tag{4}$$

where $\dot{\xi}_j^{(s)}(x_0)$ is the first order derivative of $\xi_j^{(s)}(x)$ at x_0. Define the locally weighted log-likelihood function as follows:

$$l_s(\theta^{(s)}) = \sum_{i=1}^{n} \left\{ \left[\sum_{j=2}^{J} \mathrm{I}(Y_i = j) Z_i^{(s)\bullet} \theta_j^{(s)} - \log\left(1 + \sum_{l=2}^{J} \exp(Z_i^{(s)\bullet} \theta_l^{(s)})\right) \right] \times K_h(X_{is} - x_0) \right\} \tag{5}$$

where $Z_i^{(s)\bullet} = (1, X_{is} - x_0, X_{i\backslash s}^{\bullet}), \theta_j^{(s)} = (\xi_j^{(s)}(x_0), \dot{\xi}_j^{(s)}(x_0), \alpha_j^{(s)\bullet})^{\bullet}, K_h(u) = \frac{1}{h} K\left(\frac{u}{h}\right)$, h is the bandwidth. Thus the estimation of $\theta^{(s)}$ can be achieved by maximizing a locally weighted log-likelihood function i.e:

$$\hat{\theta}^{(s)} = \arg\max_{\theta} l_s(\theta^{(s)}) \tag{6}$$

This leads to $\hat{\theta}^{(s)} = (\hat{\theta}_2^{(s)}, \dots, \hat{\theta}_J^{(s)})$, where $\hat{\theta}_j^{(s)} = (\hat{\xi}_j^{(s)}(x_0), \hat{\xi}_j^{(s)}(x_0), \tilde{\alpha}_j^{(s)\cdot})^{\cdot}$, $\hat{\xi}_j^{(s)}(x_0), \hat{\xi}_j^{(s)}(x_0)$, $\tilde{\alpha}_j^{(s)}$, respectively, $\xi_j^{(s)}(x_0), \dot{\xi}_j^{(s)}(x_0), \alpha_j^{(s)}$ is estimated.

The previous step of estimation only estimates $\alpha_j^{(s)}$ in the local neighborhood of x_0, so $\tilde{\alpha}_j^{(s)}$ obtained from the estimation of Eq. (6) is the estimator of the conjugate of $\sqrt{nh}$, and in this paper, we will use the following estimation method to obtain the estimator of the parameter $\sqrt{n}$ concordant estimator. Based on the obtained estimator $\hat{\xi}_j^{(s)}$, the likelihood function on $\alpha_j^{(s)}$ is established:

$$l_s^*(\alpha^{(s)}) = \sum_{i=1}^{n} \left\{ \sum_{j=2}^{J} \mathrm{I}(Y_i = j)(\hat{\xi}_j^{(s)}(X_{is}) + X_{i\setminus s}^{\cdot} \alpha_j^{(s)}) - \log\left(1 + \sum_{l=2}^{J} \exp(\hat{\xi}_l^{(s)}(X_{is}) + X_{i\setminus s}^{\cdot} \alpha_l^{(s)})\right) \right\} \tag{7}$$

Then $\hat{\alpha}^{(s)}$ can be obtained from the maximized likelihood function $l_s^*(\alpha^{(s)})$, i.e.

$$\hat{\alpha}^{(s)} = \arg\max_{\alpha} l_s^*(\alpha^{(s)}) \tag{8}$$

where $\hat{\alpha}^{(s)} = (\hat{\alpha}_2^{(s)}, \dots, \hat{\alpha}_J^{(s)})$.

Based on the discussion in the above section the estimate of $\mu_{ij}^{(s)}$ in the s th candidate model can be obtained as $\hat{\mu}_{ij}^{(s)} = \hat{\xi}_j^{(s)}(X_{is}) + X_{i\setminus s}^{\cdot} \hat{\alpha}_j^{(s)}$. After obtaining an estimate $\hat{\mu}_{ij}^{(s)}$ of the log odds ratio in the candidate model, model averaging is used to reduce the risk of model misclassification in order to improve the model prediction accuracy. Specifically, let $\omega = (\omega_1, \dots, \omega_d)^{\cdot}$ be the weight vector satisfying

$$\mathrm{W} = \left\{ \omega \in [0,1]^d : \sum_{s=1}^{d} \omega_s = 1 \right\} \tag{9}$$

Define the estimate of the log odds ratio after model averaging to be

$$\hat{\mu}_{ij}(\omega) = \sum_{s=1}^{d} \omega_s \hat{\mu}_{ij}^{(s)}, i = 1, \dots, n, j = 2, \dots, J \tag{10}$$

The coefficient estimation of traditional multivariate logistic regression model uses the method of great likelihood, so in the calculation process, we do not rewrite the likelihood function (5), and directly use the "multinom" function in the R language to construct a logistic regression model on the new dataset $Z_i^{(s)\cdot} = (1, X_{is} - x_0, X_{i\setminus s}^{\cdot})$ and a logistic regression model for the response variable Y, with weights chosen using the kernel function. The model returns $\hat{\theta}^{(s)}$, and the nonparametric component estimate $\hat{\xi}_j^{(s)}(x_0)$ can be obtained by taking the first column of the model, such that $x_0 = X_{ms}(m = 1, \dots, n)$, and after iteration The final estimate $\hat{\xi}_j^{(s)}(X_{1s}), \dots, \hat{\xi}_j^{(s)}(X_{ns})$ can be obtained. To compute the estimates of the linear partial coefficients $\alpha^{(s)}$, the "ucminf" function of R is used to minimize the negative log-likelihood function $(-l_s^*(\alpha^{(s)}))$, and the return value obtained is the estimated value $\hat{\alpha}^{(s)}$, and the function parameters take default values.

III. Analysis of gender differences in preschool education and evaluation of the effectiveness of educational methods

III. A. Analysis of differences in the effectiveness of preschool education

III. A. 1) Gender

The results of the comparison of gender differences in the effectiveness of preschool education are shown in Table 5. Independent samples t-test for students of different genders, the t-value of cognitive development dimension is -0.018 and p-value is 0.015, it can be concluded that there is a significant difference between girls and boys in cognitive development dimension and the cognitive developmental effect of girls (3.85±0.46) is slightly higher than that of boys (3.17±0.72) in all the indicators. The t-value of the dimension of social development is -2.215 and p-value is 0.026, it can be concluded that there is also a significant difference between boys and girls in social development and the effect of social development is significantly higher in girls (3.58±0.47) than in boys (3.22±0.54). The t-value of study habit dimension is -3.018 and p-value is 0.001, it can be concluded that there is a significant difference between boys and girls in study habit dimension and the study habit of girls (3.59±0.78) is much higher than that of boys (3.01±1.09).

Table 5: Gender Differences in Preschool Education Effects

Dimension	Gender	Number of people	Mean value±SD	t	p
Cognitive development	Male	188	3.17±0.72	-0.018	0.015
	Female	162	3.85±0.46		
Social development	Male	188	3.22±0.54	-2.215	0.026
	Female	162	3.58±0.47		
Study habit	Male	188	3.01±1.09	-3.018	0.001
	Female	162	3.59±0.78		

From the above data, it is clear that there are significant differences in kindergarten students' preschool education effectiveness in all three dimensions: cognitive development, social development, and study habits. Girls scored higher than boys in all of them, especially in the dimension of study habits, where the difference between boys and girls was the largest, and overall the effectiveness of preschool education for boys was significantly lower than that of girls.

III. A. 2) Grades

The results of the grade-level differences in preschool effectiveness are shown in Table 6. Kindergarten students scored slightly higher than other grades on all three dimensions in the middle grades, but the significance level for each dimension was greater than 0.05 ($p>0.05$), indicating that there were no significant differences in preschool effectiveness for kindergarten students at the grade level.

Table 6: Differences in preschool Education Effects among Different grades

Dimension	Grade	Number of people	Mean value±SD	t	p
Cognitive development	Lower grades	68	3.49±0.78	15.356	0.054
	Middle Section	170	3.50±0.62		
	Senior Grade	112	3.46±0.56		
Social development	Lower grades	68	3.38±0.93	10.254	0.061
	Middle Section	170	3.41±0.71		
	Senior Grade	112	3.36±0.68		
Study habit	Lower grades	68	3.24±0.85	12.483	0.125
	Middle Section	170	3.26±0.78		
	Senior Grade	112	3.33±0.46		

III. B. Regression analysis of the effects of preschool education

III. B. 1) Regression analysis of preschool education on cognitive development

This paper uses multiple step-by-step regression method to analyze the regression of preschool education on cognitive development to derive the regression model. The step-by-step multiple regression can eliminate the independent variables that do not have a significant effect on the dependent variable step by step and finally leave the independent variables that have a significant effect on the dependent variable, so as to construct the best model. The regression of preschool education on cognitive development is shown in Table 7, and the R^2 is 0.437, which indicates that the regression equation can explain 43.7% of the original variables, the tolerance is close to 1, and the VIF is less than 10, so there is no covariance between the independent variables, and the equation is well fitted.

From the above regression model, it can be seen that five variables: verbal expression ability, logical thinking, spatial cognitive ability, memory ability, and problem solving ability entered the model. At the level of variable contribution, verbal expressive ability ($\beta=0.153$, $p=0.033$) and logical thinking ($\beta=0.114$, $p=0.002$) showed a significant positive effect. The contribution of spatial cognitive ability ($\beta=0.089$, $p=0.018$) and memory ability ($\beta=0.106$, $p=0.001$) was lower than the previous two, but still passed the statistical significance test ($p<0.05$). Although the standardized coefficient of problem solving ability ($\beta=0.118$, $p=0.015$) was the second highest, the ratio of its unstandardized coefficient ($B=0.155$) to the standard error ($SE=0.055$) amounted to 2.818, which indicated that its actual marginal effect on cognitive development was better than that expected from theory.

From the perspective of educational practice, the significant effects of verbal expression and logical thinking confirm the fundamental role of symbolic system construction for cognitive development, while the significance of spatial cognition and memory ability suggests the need to strengthen figurative thinking training. The difference between the high standardized coefficients and the relatively low raw coefficients for problem solving ability may stem from the complexity of its measurement dimensions. The model validates the mechanism by which preschool education promotes cognitive development through the synergistic action of multidimensional abilities.

Table 7: The return of preschool education to cognitive development

Variable	Non-standardized coefficient		Standardized coefficient	t	Sig.	Collinear statistics		R^2
	B	SE	β			Tol	VIF	
Constant	.378	.082		1.275	.063			.437
Language expression ability	.153	.066	.153	2.187	.033	.783	1.258	
logical thinking	.172	.071	.114	1.056	.002	.802	1.239	
Spatial cognitive ability	.136	.058	.089	2.023	.018	.695	1.775	
Memory ability	.108	.069	.106	1.775	.001	.886	1.636	
Problem solving ability	.155	.055	.118	1.832	.015	.901	1.285	

III. B. 2) Regression analysis of preschool education on social development

In this paper, we do stepwise multiple regression of preschool education on social development, and the regression results are shown in Table 8. As seen in Table 8, R^2 is 0.452, which indicates that the regression equation can explain 45.2% of the original variables, the tolerance is close to 1, and the VIF is less than 10, so there is no covariance between the independent variables, and the equation fits well.

From the regression model, it can be seen that cooperation ability, rule awareness, adaptability, and moral judgment entered the equation. At the level of variable contribution, cooperative ability (β=0.133, p=0.023) and rule awareness (β=0.198, p=0.008) showed a significant positive effect. Although the standardized coefficient of adaptability (β=0.112, p=0.016) and moral judgment (β=0.086, p=0.005) are low, the unstandardized coefficients (B-value of 0.227 and 0.098, respectively) and standard error ratios are over the critical value of 1.96, suggesting that their actual marginal effects on children's social development are statistically significant. In terms of the variable's mechanism of action, the unstandardized coefficient of cooperation ability (B=0.305) is significantly higher than the other variables, and combined with its standardized coefficient (β=0.133), it can be deduced that the variable's actual contribution to the effect of preschool education has a practical priority.

Table 8: The return of preschool education to social development

Variable	Non-standardized coefficient		Standardized coefficient	t	Sig.	Collinear statistics		R^2
	B	SE	β			Tol	VIF	
Constant	.092	.031		1.775	.573			.452
Cooperation ability	.305	.052	.133	1.134	.023	.568	1.867	
Rule consciousness	.286	.024	.198	1.268	.008	.872	1.256	
Adaptability	.227	.037	.112	.958	.016	.739	1.375	
Moral judgment	.098	.028	.086	2.023	.005	.595	1.118	

III. B. 3) Regression analysis of preschool education on study habits

In this paper, we do stepwise multiple regression of preschool education on study habits, and the regression results are shown in Table 9. r^2 is 0.492, which indicates that the regression equation can explain 49.2% of the original variables, the tolerance is close to 1, and the VIF is less than 10, so there is no covariance among the independent variables, and the equation is well fitted.

From the regression model, it can be seen that learning initiative, learning strategy, self-control, time management skills, entered the equation ($p<0.05$). In terms of the strength of the variable's effect, learning strategy (β=0.612, p=0.003) was the most significant predictor variable, and its standardized coefficient indicated that for every 1-unit improvement in this variable, the study habit score would increase by 0.612 standard deviations, reflecting the central driving role of strategic learning ability in the development of behavioral patterns. Learning initiative (β=0.508, p=0.002) is the next most important, confirming the continuous reinforcement effect of active learning awareness on habit formation. Self-control (β=0.303, p=0.001) and time management skills (β=0.297, p=0.001) showed statistically significant ($p<0.05$), although the degree of influence was relatively low.

In summary, the preschool education stage can significantly promote the standardized development of learning habits by systematically cultivating learning strategies, stimulating active learning motivation, and reinforcing self-regulation and time management ability, in which the cultivation of strategic learning ability should be the key direction of educational intervention.

Table 9: The return of learning habits in preschool education

Variable	Non-standardized coefficient		Standardized coefficient	t	Sig.	Collinear statistics		R^2
	B	SE	β			Tol	VIF	
Constant	.583	.266		3.485	.067			.492
Learning initiative	.153	.083	.508	3.105	.002	.963	1.258	
Learning strategy	.167	.054	.612	2.031	.003	.885	1.085	
Self-control	.155	.066	.303	3.968	.001	.901	1.334	
Time management ability	.094	.085	.297	3.025	.001	.806	1.289	

IV. Conclusion

Based on the regression model, this paper explores the gender difference analysis of kindergarten students' pre-school education and evaluates the effect of educational methods, and the main conclusions are as follows.

(1) Gender differences are significant: girls are better than boys in the three dimensions of cognitive development, social development and study habits, with p-values of 0.015, 0.026 and 0.001, respectively, which can be concluded that there are significant differences between boys and girls in the three dimensions, with the largest difference in study habits ($t=-3.018$, $p=0.001$), indicating that it is necessary to strengthen the guidance of boys' study behaviors in a targeted manner.

(2) The key role of educational approach: the regression equation for preschool education on cognitive development has an R^2 of 0.437, a tolerance close to 1, and a VIF of less than 10. Expressive language skills ($\beta=0.153$, $p=0.033$) and logical thinking ($\beta=0.114$, $p=0.002$) showed a significant positive effect. The contribution of spatial cognitive ability ($\beta=0.089$, $p=0.018$) and memory ability ($\beta=0.106$, $p=0.001$) was lower than the previous two, but still passed the statistical significance test ($p<0.05$). The standardized coefficient of problem solving ability ($\beta=0.118$, $p=0.015$) was the second highest, but the ratio of its unstandardized coefficient (B=0.155) to the standard error (SE=0.055) amounted to 2.818.

The regression equation of preschool education on social development had an R^2 of 0.452, with a tolerance close to 1 and a VIF less than 10. Cooperative ability ($\beta=0.133$, $p=0.023$) and rule awareness ($\beta=0.198$, $p=0.008$) showed a significant positive effect. Although the standardized coefficient of adaptability ($\beta=0.112$, $p=0.016$) and moral judgment ($\beta=0.086$, $p=0.005$) were low, the unstandardized coefficients (B-value of 0.227 and 0.098, respectively) and standard error ratios exceeded the critical value of 1.96.

The regression equation of preschool education on study habits had an R^2 of 0.492 with a tolerance close to 1 and a VIF less than 10. Learning strategy ($\beta=0.612$, $p=0.003$) was the most significant predictor variable, followed by learning initiative ($\beta=0.508$, $p=0.002$), and self-control ($\beta=0.303$, $p=0.001$) and time management skills ($\beta=0.297$, $p = 0.001$) showed statistical significance ($p<0.05$), although the degree of influence was relatively low.

(3) Practical implication: the formation of gender differences may stem from the dual role of physiology and socio-culture. From the perspective of cognitive development, girls have an inherent advantage in figurative thinking domains such as verbal expression and memory skills, while boys' potential in abstract thinking domains such as spatial cognition has not yet been fully activated. At the socio-cultural level, traditional gender role expectations may have reinforced girls' behavioral patterns, indirectly leading to gender differentiation in learning habits. In addition, differences in gendered parenting styles in family education may also exacerbate this phenomenon.

In conclusion, the systematic cultivation of learning strategies, motivation for active learning, self-regulation and time management in preschool education can significantly promote the standardized development of learning habits, in which the standardized coefficient of learning strategies on learning habits reaches 0.612, and the cultivation of strategic learning skills should be the focus of educational interventions.

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