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The Multivariate Differences of Key Factors in Early Childhood Teacher Professional Development in Shandong Province

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ABSTRACT

As China's preschool education system transitions from scale expansion to quality-oriented development, teachers' professional competence has become a critical determinant of educational quality. However, empirical evidence remains limited regarding how organizational and individual factors differentially influence teachers' professional knowledge, teaching behavior, and instructional innovation. This study employed a quantitative research design using stratified random sampling. Data were collected through a questionnaire survey administered to 500 in-service preschool teachers in Linyi, Weifang, and Jining, Shandong Province, China. Four independent variables—teacher educational qualifications, quarterly training frequency, kindergarten size, and directors' leadership styles—were examined. Teachers' professional competence was operationalized across three dimensions: professional knowledge, teaching behavior, and instructional innovation. Multivariate analysis of variance (MANOVA) was applied to test the differential effects of the independent variables on the dependent constructs. The results indicate that quarterly training frequency is the most influential and comprehensive predictor of preschool teachers' professional competence, demonstrating significant positive effects across all three dimensions. Directors' transformational leadership style significantly outperforms transactional and servant leadership in enhancing teachers' professional knowledge depth, optimizing interactive teaching behaviors, and stimulating instructional innovation. Teachers' educational qualifications significantly predict professional knowledge accumulation and innovation potential but do not exert a statistically significant effect on routine teaching behaviors. Kindergarten size shows no significant impact on any dimension of teachers' professional competence. The findings highlight the pivotal role of organizational "soft power," particularly systematic professional training and transformational leadership, in fostering preschool teachers' professional development. Compared with structural or scale-based investments, capacity-building mechanisms generate substantially greater returns for improving educational quality. These results provide empirical support for policy and management strategies that prioritize professional learning systems and leadership development to advance high-quality preschool education in China.

Keywords: Early Childhood Teacher Professional Development, Teacher Knowledge, Teacher Behavior, Teaching Innovation

INTRODUCTION

In global education reform, the quality of Early Childhood Education (ECE) has been widely recognized as the cornerstone of national human capital accumulation and the starting point for social equity. With

groundbreaking advances in neuroscience and developmental psychology, the international community is increasingly reaching consensus: the professional competence of early childhood teachers is a core determinant of childcare quality and promotes children's holistic development (OECD, 2019; Zhang & Ng, 2022). Against this backdrop, deconstructing the driving mechanisms of teacher professional development from a management perspective has become a cutting-edge topic in global educational research.

In China, early childhood education is undergoing a profound historical transformation from quantitative expansion to high-quality, intrinsic development (OECD, 2019). With the implementation of the three-child policy, the Chinese government has clearly stated its intention to build a high-quality, professional early childhood teacher workforce（Wang & Li, 2023). As a populous province and educational hub in eastern China, Shandong Province's preschool education development is highly typical and representative. Despite the ongoing release of macro-policy dividends, teacher professional development continues to face severe structural challenges in micro-regional practices (Cao et al., 2020). In Shandong Province, there are significant gradients in economic development levels, educational resource allocation, and management culture among Weifang, Linyi, and Jining. This regional heterogeneity provides a research field for exploring differentiated paths to teacher professional development across different environments.

However, a review of existing literature reveals that despite the vast amount of research on teacher professional development, significant research gaps remain in the following key dimensions:

Existing research often focuses on single dimensions, such as the impact of training on skills or the role of academic qualifications in knowledge acquisition. According to Shulman's (1987) classic PCK theory, teacher professionalism is a synthesis of knowledge, behavior, and innovation. However, few studies construct integrated models to examine how external management variables (such as directors' leadership style and training frequency) differentially affect these three distinct yet interconnected internal dimensions (Chen & Zheng, 2023). In educational management practice, administrators often prioritize hard factors (such as expanding kindergarten enrollment or simply raising academic qualification requirements) while neglecting the role of the soft environment (such as the director's leadership style and organizational climate). But in China's unique administrative management context, is the input of material resources (scale) more important, or is the reshaping of management culture (leadership) more crucial? Currently, there is a lack of quantitative empirical evidence based on large-sample data (Yang, 2021).

Existing research on Chinese preschool teachers largely relies on qualitative descriptions or simple correlational analyses, lacking rigorous causal inferences. Particularly concerning are complex relationships involving multiple independent variables (teacher qualifications, training, scale, leadership) and multiple dependent variables (knowledge, behavior, innovation). Few studies utilize multivariate analysis of variance (MANOVA) to control for error and accurately isolate the net effects of each factor. This makes it difficult to determine whether the lagging teacher quality in a particular region is due to low educational qualifications or insufficient training.

Based on the above background and research gaps, this study takes Shandong Province, China, as the empirical field and selects 500 kindergarten teachers from Linyi, Weifang, and Jining as the research sample. The aim is to develop a comprehensive analytical framework that integrates individual characteristics (teachers' highest academic qualification), organizational characteristics (kindergarten size), management mechanisms (quarterly training frequency), and leadership environment (director's leadership style).

Research Objectives

1. To study the levels of teacher knowledge, teacher behavior, and teaching innovation for early childhood teachers in Shandong Province.
2. To compare and examine the multivariate differences of key factors in early childhood teacher professional development---namely, teachers' highest academic qualification, quarterly training times, kindergarten size, and director's leadership style.

LITERATURE REVIEW AND HYPOTHESES

Theoretical Basis

Teacher Development Theory

Teacher development theory provides the conceptual basis for the study's dependent variable. According to Shulman's (1987) classic content-based knowledge (PCK) theory, a teacher's professionalism lies not only in mastering subject content but also in the ability to translate knowledge into a comprehensible teaching format for students (Blömeke & Gustafsson, 2023). Shulman's theory provides the basis for defining teacher knowledge in this study: a comprehensive cognitive system encompassing subject knowledge, pedagogical knowledge, and knowledge of educational psychology. However, knowledge is not the end point of professional development. Day

(1999) points out that teacher development is a dynamic process involving the mind (knowledge) and the heart (emotions/behaviors), emphasizing the quality of teachers' real-time responses and interactions in the classroom context (Schleicher, 2020).

Based on the perspectives of Shulman and Day, we deconstruct professional development into three core dimensions: cognition (teacher knowledge), practice (teacher behavior), and adaptation (teaching innovation). This theory reveals the logic of teachers' evolution from novices to experts: from knowledge accumulation to behavioral internalization, ultimately achieving teaching innovation.

Resource-Based Theory

Resource-Based Value (RBV) theory posits that an organization's unique, scarce, and inimitable resources are the root of its performance differences. In the context of preschool education, teachers' academic qualifications and in-service training are considered key human capital resources (Bao & Miao, 2021). According to Darling-Hammond (2017), teachers' academic backgrounds (degrees) not only represent their pre-service knowledge reserves but also determine their potential to absorb new knowledge and engage in higher-order thinking. Meanwhile, continuous in-service training is regarded as an organizational reinvestment in human resources, helping prevent the depreciation of human capital through ongoing knowledge updates (Sims & Fletcher-Wood, 2021).

This study treats teacher qualifications as core human capital, in-service training as a dynamic investment in organizational knowledge resources, and kindergarten size as the material basis. Based on the RBV (Resource-Based View), we define these elements as key resource inputs that drive development. The study aims to assess whether these hard resources translate into teachers' outputs in knowledge, behavior, and innovation, particularly whether high-frequency training, as a scarce resource, is a decisive variable explaining differences in teachers' professional development.

Leadership Theory

This study introduces Bass's holistic leadership model, particularly his transformational, transactional, and servant leadership theories, to explain the impact of the organizational environment on teachers (Gumus et al., 2020). Fullan (2016), in his research on educational change, points out that leaders can significantly alter teachers' motivation and behavioral patterns by constructing a vision, providing intellectual stimulation (transformational), or providing a supportive environment (servant) (Strehmel et al., 2022).

Applying Bass's holistic leadership model, this study considers the principal's leadership style as the core force shaping the organizational learning atmosphere. The study aims to empirically test whether the visionary appeal and intellectual stimulation of transformational leadership significantly drive teachers' breakthroughs in knowledge depth and innovative practice more effectively than transactional reward and punishment mechanisms and service-oriented emotional support.

Hypothesis Development

Teacher's Highest Academic Qualification

Teachers' academic qualifications are generally considered the cognitive starting point for their professional development. According to Shulman (1987), a strong foundation of subject knowledge is a prerequisite for effective teaching. Teachers with higher education (e.g., undergraduate and master's degrees) typically receive more structured training in child development psychology, educational philosophy, and curriculum theory during their pre-service training. Therefore, compared to teachers with associate degrees, teachers with higher education should have a significant advantage in the breadth and depth of their teacher knowledge (H1).

While academic qualifications primarily affect the cognitive level, their potential impact on teaching innovation cannot be ignored. Innovation often requires breaking conventional mindsets and integrating interdisciplinary knowledge. The research by Darling-Hammond et al. (2017) shows that teachers with higher academic qualifications are more likely to adopt advanced teaching methods, such as inquiry-based learning, and to possess stronger curriculum design and optimization abilities (H3). However, existing research on the impact of academic qualifications on daily teacher behavior (such as teacher-child interaction and classroom management) is inconsistent. Based on the logic of human capital theory, we expect that higher academic qualifications will support standardized and professional teaching behaviors (H2).

H1: There is a significant difference in teacher knowledge of early childhood teachers at different levels of education.

H2: There is a significant difference in the teacher behavior of early childhood teachers at different levels of education.

H3: There is a significant difference in teaching innovations of early childhood teachers at different levels of education.

Quarterly Training Times

In-service training is a primary means of updating knowledge and refining skills throughout a teacher's career. Guskey's (2002) teacher professional development assessment model emphasizes that effective training can trigger a chain reaction in teachers' knowledge, beliefs, and practices. This study focuses specifically on training frequency, i.e., the number of training sessions per quarter, viewing it as a dosage effect.

Frequent training (e.g., more than twice per quarter) ensures that teachers have timely access to the latest educational philosophies and policy directions, thereby significantly expanding their knowledge base (H4). Changes in teaching behavior often require continuous reinforcement and feedback. Pianta et al. (2016), in their research on teacher-child interaction, noted that through continuous guidance and practice, teachers can internalize theory into concrete, high-quality emotional support and teaching-organization behaviors (H5). Training is often a source of inspiration for innovation. By exposing teachers to diverse teaching cases and cutting-edge methods, frequent training can break down their path dependence, reduce their fear of change, and thus stimulate their willingness and practice of teaching innovation (H6).

H4: There is a significant difference in teacher knowledge of early childhood teachers with different numbers of quarterly trainings.

H5: There is a significant difference in the teacher behavior of early childhood teachers with different numbers of quarterly trainings.

H6: There is a significant difference in teaching innovations of early childhood teachers with different number of quarterly trainings.

Kindergarten Size

Kindergarten size, as an important organizational structure variable, has two diametrically opposed theoretical explanations for its impact on teacher development. On the one hand, based on resource dependence theory, large kindergartens typically have more abundant funding, more advanced teaching and research equipment, and more diverse expert resources, providing a material foundation for teachers' knowledge acquisition and innovative practices. On the other hand, Hargreaves & Fullan's (2021) professional capital theory reminds us that excessively large organizational sizes may lead to bureaucratic rigidity, hindering in-depth collaboration and informal communication among teachers; while small and medium-sized kindergartens may have closer social networks and more flexible decision-making mechanisms, which are conducive to the dissemination of tacit knowledge and rapid adjustment of teaching behaviors.

This study hypothesizes that organizational ecosystems of different sizes (small/medium/large) will exhibit distinct balance points between resource supply and interaction efficiency, thereby having a differentiated impact on teachers' professional development outcomes.

H7: There is a significant difference in teacher knowledge of early childhood teachers of different kindergarten sizes.

H8: There is a significant difference in the teacher behavior of early childhood teachers of different kindergarten sizes.

H9: There is a significant difference in teaching innovation among early childhood teachers of different kindergarten sizes.

Director's Leadership Style

As the chief education officer of a kindergarten, the director's leadership style directly determines the organization's psychological atmosphere and behavioral norms. Transformational leadership aims to enhance subordinates' intrinsic motivation by fostering a shared vision, providing intellectual stimulation, and offering personalized care. Fullan (2016) argues that this style best encourages teachers to challenge the status quo, thereby significantly promoting pedagogical innovation and deep knowledge construction. Transactional leadership, based on contracts and exchanges, regulates employee behavior through clear reward and punishment mechanisms. This style may be very effective in ensuring that teachers adhere to routines and meet basic behavioral standards, but it may have limitations in stimulating higher-order innovation. Servant leadership emphasizes meeting subordinates' needs through service and empowerment. This style helps create a safe and supportive psychological environment and may positively affect teachers' emotional behavior and knowledge sharing.

In summary, this study anticipates that different directors' leadership styles will have significantly different impacts on the three dimensions of teacher professional development by shaping distinct organizational learning cultures.

H10: There is a significant difference in teacher knowledge of early childhood teachers with different directors' leadership styles.

H11: There is a significant difference in teacher behavior of early childhood teachers with different director's leadership styles of directors.
H12: There is a significant difference in teaching innovation among early childhood teachers with different director's leadership styles of directors.

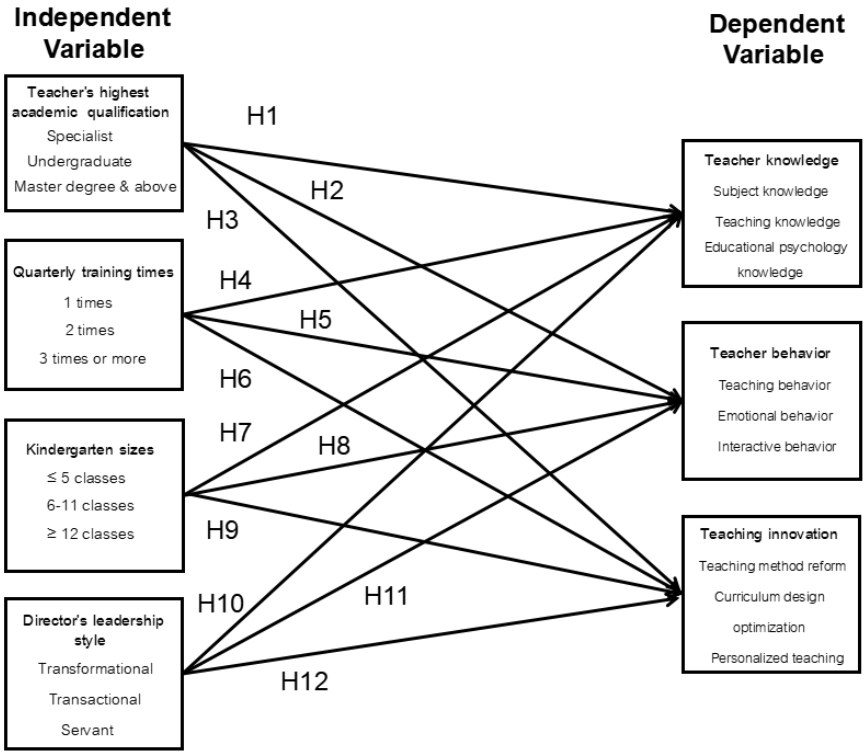

Figure 1 Conceptual framework

METHODOLOGY

Research Subjects and Sampling

This study was conducted in Shandong Province, a representative education center in eastern China. To ensure the representativeness of the sample, a stratified random sampling method was used, selecting Weifang, Linyi, and Jining as the research subjects. These three cities were chosen to represent different stages of preschool education development and socioeconomic background within Shandong Province. The target population consisted of in-service preschool teachers in both public and private kindergartens. The sampling process consisted of two stages: first, 50 kindergartens were randomly selected from the three cities based on the teacher-to-population ratio; second, teachers from these kindergartens were invited to participate in a questionnaire survey. After removing incomplete questionnaires, 500 valid questionnaires were retained for analysis. The sample size (N=500) met the requirements for multivariate statistical power, ensuring the robustness of the subsequent multivariate analysis of variance (MANOVA).

Measuring Tools

The structured questionnaire used in this study consisted of two parts, developed from a systematic literature review and validated through expert review and pretesting. This part collected data on four categorical independent variables (IVs): education level (divided into associate's, bachelor's, and master's degrees or above); training frequency (measured by the number of professional training sessions attended per quarter (1, 2, or ≥3) ; kindergarten size (categorized by the number of classes: small (≤5 classes); medium (6-11 classes); large (≥12 classes); and director's leadership style (determined based on teachers' perceptions of their principal's primary director's leadership style: transformational leadership, transactional leadership, or servant leadership).

The dependent variable was measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) across three core dimensions of teacher professional development. These scales were adapted from existing research tools (e.g., Shulman, 1987; Pianta et al., 2016; Fullan, 2016) to suit the realities of preschool education in China: Teacher Knowledge (36 items), assessing subject knowledge, pedagogical knowledge, and educational psychology knowledge; Teacher Behavior (33 items), assessing teaching behavior, emotional behavior, and

interactive behavior; and Teaching Innovation (39 items), assessing teaching method reform, curriculum design optimization, and personalized teaching.

The Cronbach's α coefficients for the three main scales were 0.826 (knowledge), 0.827 (behavior), and 0.826 (innovation), with the total scale reaching 0.822, all exceeding the recommended threshold of 0.70 (Hair et al., 2010). The KMO values for all constructs were greater than 0.85, and the Bartlett test results were significant ($p < .001$), indicating excellent construct validity.

Data Analysis Strategy

Multivariate analysis of variance (MANOVA) was selected as the primary statistical method, and the analysis followed a two-step procedure: testing for multiple main effects (Wilks' Lambda) to determine whether the independent variables had a significant effect on the pooled dependent variable; and performing univariate tests and Tukey's HSD post-hoc comparisons to identify specific between-group differences.

DATA ANALYSIS AND RESULTS

Descriptive Statistics

Demographic Characteristics of Respondents

This survey collected 500 valid questionnaires from Shandong Province. The demographic characteristics of the sample are shown in Table 1. The sample is predominantly female (97.8%), consistent with the gender distribution in China's early childhood education industry. Regarding age, most respondents are in the early to mid-stages of their careers: 33.6% are 20-29 and 61.6% are 30-39, indicating a relatively young workforce in this industry. In terms of educational background, the majority of respondents hold a bachelor's degree (66.6%), followed by an associate's degree (27.2%), while the proportion of respondents with a master's degree or higher is relatively small (6.2%). See Tables 1 and 2 for details.

Table 1: Distribution of basic information of cities

Item	Category	Weifang		Linyi		Jining		Overall	
		Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)
	Female	146	97.30	196	98.00	147	98.00	489	97.80
Gender	Male	4	2.70	4	2.00	3	2.00	11	2.20
Overall		150	100.00	200	100.00	150	100.00	500	100.00
	20-29	33	22.00	59	29.50	76	50.70	168	33.60
	30-39	108	72.00	130	65.00	70	46.70	308	61.60
Age	40-49	9	6.00	11	5.50	4	2.60	24	4.80
Overall		150	30.00	200	40.00	150	30.00	500	100.00

Table 1 Distribution of independent variables among sample teachers

Independent Variables	Category	Weifang		Linyi		Jining		Overall	
		Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)
Highest educational attainment of teachers	Specialist	30	20.00	50	25.00	56	37.30	136	27.20
	Bachelor's	104	69.30	139	69.50	90	60.00	333	66.60
	Master's and above	16	10.70	11	5.50	4	2.70	31	6.20
	Overall	150	100.00	200	100.00	150	100.00	500	100.00
Number of quarterly	1	45	30.00	69	34.50	74	49.30	188	37.60
	2	30	20.00	95	47.50	56	37.30	181	36.20

training sessions	3 times and above	75	50.00	36	18.00	20	13.30	131	26.20
	Overall	150	100.00	200	100.00	150	100.00	500	100.00
Kindergarten school's size	Small	36	24.00	44	22.00	43	28.70	123	24.60
	Medium	39	26.00	54	27.00	47	31.30	140	28.00
	Large	75	50.00	102	51.00	60	40.00	237	47.40
	Overall	150	100.00	200	100.00	150	100.00	500	100.00
Director's Leadership Style	Transformational	80	53.30	41	20.50	29	19.30	150	30.00
	Transactional	16	10.70	105	52.50	45	30.00	166	33.20
	Servant	54	36.00	54	27.00	76	50.7 0	184	36.80
	Overall	150	100.00	200	100.00	150	100.00	500	100.00

Descriptive Analysis of Key Variables

Table 3 summarizes the descriptive statistics for the key dependent variables across the three cities and the overall sample. The overall means for teacher knowledge (mean = 3.32, standard deviation = 0.60), teacher behavior (mean = 3.31, standard deviation = 0.62), and teaching innovation (mean = 3.33, standard deviation = 0.61) are all in the middle range (approximately 3.3 out of 5). This indicates that while preschool teachers in Shandong Province possess a certain level of professional competence, there remains significant room for improvement to elevate their practice to an excellent standard.

It is worth noting that there are significant regional differences. Teachers in Weifang City scored the highest across all dimensions (average approximately 3.95), indicating a high level of professional development. In contrast, teachers in Jining City scored the lowest (average approximately 2.58), indicating a need for targeted support, whereas those in Linyi City scored in the middle (average approximately 3.42).

Table 3: Descriptive statistics of dependent variables

n	Variable	Mean	Standard deviation	Variance	Skewness	Kurtosis
150	Teacher knowledge	3.94	0.17	0.03	-0.30	-0.18
	Teacher Behavior	3.96	0.16	0.03	-0.30	-0.13
	Teaching Innovation	3.96	0.18	0.03	-0.25	0.59
200	Teacher Knowledge	3.42	0.32	0.10	-0.62	-0.77
	Teacher Behavior	3.41	0.34	0.12	-0.74	-0.64
	Teaching Innovation	3.42	0.34	0.12	-0.79	-0.52
150	Teaching Knowledge	2.59	0.30	0.09	0.55	-0.84
	Teaching Behavior	2.56	0.32	0.10	0.74	-0.60
	Teaching Innovation	2.60	0.32	0.10	0.74	-0.66

Preliminary Hypothesis Testing for MANOVA

Before conducting the multivariate analysis of variance (MANOVA), we rigorously tested the fundamental assumptions of homogeneity of variances and homogeneity of covariance matrices. Homogeneity of variance test (Levene test): The Levene test was performed to assess the equality of error variances across groups of dependent variables. The results showed that the test statistics were not significant for all dependent variables (education level, training, size, and leadership) ($p > .05$). Homogeneity of covariance matrix (Box's M test): The Box's M test was used to test the homogeneity of covariance matrices across groups. The results showed that the test statistics for all independent variables were not statistically significant; therefore, the null hypothesis of equal covariance matrices could not be rejected. The data met all necessary preconditions, thereby validating the use of multivariate analysis of variance (MANOVA) for subsequent hypothesis testing.

Hypothesis Testing Results

The Impact of Teacher's Highest Academic Qualification(H1-H3)

The multivariate main effect of education level was statistically significant (Wilks' $\lambda = .910$, $F(6, 990) = 8.093$, $p < .001$, $\eta p^2 = .047$), indicating that teachers' educational backgrounds have a significant impact on their overall professional development.

Teacher Knowledge (H1): Educational background had a significant impact ($F = 14.899$, $p < .001$), supporting hypothesis H1. Post-hoc comparisons (Tukey's HSD) showed a clear hierarchical structure: teachers with master's degrees scored significantly higher than those with bachelor's degrees, and those with bachelor's degrees scored

significantly higher than those with associate's degrees. Instructional Innovation (H3): Innovative ability also had a significant impact ($F = 4.632$, $p = .010$), supporting hypothesis H3. Higher education was associated with stronger capabilities in curriculum design and methodological reform. Teacher Behavior (H2): However, no significant differences were found in teacher behavior ($F = 2.508$, $p = .083$). This led to the rejection of hypothesis H2, indicating that higher education does not automatically translate into better daily teaching practices in the absence of mediating factors.

Table 4 Results of between-subjects effects tests on the influence of teachers' educational attainment on each dependent variable

Source	Dependent Variable	III-type sum of squares	df	Mean Square	F	p-value	Partial Eta-squared (Partial η^2)
	Teacher knowledge	**11.099**	**2**	**5.550**	**14.899**	**0.001**	**0.057**
	Teacher Behavior	**1.838**	**2**	**0.919**	**2.508**	**0.083**	**0.010**
Adjusted model	**Teaching Innovation**	**3.232**	**2**	**1.616**	**4.632**	**0.010**	**0.018**
	Teacher Knowledge	7119.987	1	7119.987	19120.354	0.001	0.975
	Teacher Behavior	6982.982	1	6982.982	19045.242	0.001	0.975
Intercept	Teaching Innovation	6828.611	1	6828.611	19,576.456	0.001	0.975
	Teacher Knowledge	11.099	2	5.550	14.899	0.001	0.057
	Teacher Behavior	1.838	2	0.919	2.508	0.083	0.010
Educational Attainment	Teaching Innovation	3.232	2	1.616	4.632	0.010	0.018
	Teacher knowledge	185.127	497	0.372			
	Teacher Behavior	182.203	497	0.367			
Error	Teaching Innovation	173.398	497	0.349			
	Teacher Knowledge	7,317	500				
	Teacher Behavior	7,167	500				
Overall	Teaching Innovation	7005	500				
	Teacher Knowledge	196.226	499				
	Teacher Behavior	184.041	499				
Overall Corrections	Teaching Innovation	176.63	499				

The Impact of Quarterly Training Times (H4-H6)

Analysis shows that training frequency has the greatest impact among all independent variables (Wilks' $\lambda = .820$, $F(6, 990) = 17.887$, $p < .001$, $\eta p^2 = .098$), confirming that on-the-job training frequency is an important driver of professional development.

Univariate analysis (Table 5) showed significant differences across the three dimensions of knowledge ($F=34.686$), behavior ($F=16.920$), and innovation ($F=22.846$), with all p-values $< .001$. Post hoc tests revealed a consistent dose-response relationship: teachers attending ≥3 training sessions per quarter significantly outperformed those attending 2 sessions, and those attending 2 sessions outperformed those attending only 1. Unlike academic qualifications, training frequency significantly improved teacher behavior ($\eta p^2 = .064$), indicating that continuous practical training is crucial for shaping daily classroom interactions. Therefore, hypotheses H4, H5, and H6 are strongly supported.

Table 5 Results of between-subjects effects tests on the influence of quarterly training frequency on each dependent variable

Source	Dependent Variable	III Sum of squares	df	Mean square	F	p-value	Partial Eta-squared (Partial η^2)
Number of quarterly training sessions	Teacher knowledge	23.361	2	11.681	34.686	0.001	0.122
	Teacher behavior	11.789	2	5.895	16.920	0.001	0.064

	Teaching innovation	15.150	2	7.575	22.846	0.001	0.084

The Impact of Kindergarten Size (H7-H9)

The multivariate test for kindergarten size was not significant (Wilks' λ = .993, F(6, 990) = 0.598, p = .732, ηp^2 = .004), indicating that kindergarten size (small, medium, or large) has no significant impact on teachers' professional development. Since the main multivariate effect was not significant, no further analysis of the univariate test results was conducted. Therefore, hypotheses H7, H8, and H9 were rejected. This insignificant result has important theoretical implications because it suggests that, in the context of preschool education in China, soft factors (such as training and leadership) may be more influential than hard structural factors (such as size).

The Impact of the Director's Leadership Style (H10-H12)

The multivariate main effect of the director's leadership style was statistically significant (Wilks' λ = .963, F(6, 990) = 3.141, p = .005, ηp^2 = .019), confirming that the director's leadership style has a significant impact on students' academic performance.

Transformational leadership plays a crucial role in teacher development. Univariate tests (Table 6) show that transformational leadership has a significant impact on all three dimensions: knowledge (p=.033), behavior (p=.007), and innovation (p=.006). Post hoc comparisons consistently indicate that transformational leadership is the most effective leadership style among directors. Teachers under transformational leadership scored significantly higher than those under transactional or servant leadership across all dimensions. Interestingly, while transactional leadership (focusing on rewards and punishments) and servant leadership (focusing on support) also showed some positive effects, they were significantly less effective than transformational leadership in promoting innovation and high-quality behavior. Therefore, hypotheses H10, H11, and H12 are supported, highlighting the superiority of transformational leadership in education.

Table 6 Results of between-subjects effect tests on the influence of directors' leadership styles on each dependent variable

Source	Dependent Variable	III-type sum of squares	df	Mean Square	F	p-value	Partial Eta-squared (Partial η^2)
Director's Leadership Style	Teacher Knowledge	2.620	2	1.311	3.444	0.033	0.014
	Teacher behavior	3.670	2	1.835	5.087	0.007	0.02 0
	Teaching Innovation	3.585	2	1.793	5.115	0.006	0.02 0

DISCUSSION AND CONCLUSION

Quantitative analysis showed that training frequency was the strongest predictor among the three dimensions of professional development (ηp^2 = 0.098). This finding strongly supports Guskey's (2002) model, which posits that continuous professional learning is crucial for changing teachers' practices and beliefs. Teachers who participated in more than three training sessions per quarter significantly outperformed other teachers, a finding strongly supported by qualitative interviews in which teachers described high-frequency training not only as a source of information but also as a preservative to prevent knowledge from becoming obsolete and as a corrector of behavioral habits.

Research confirms that a director's leadership style is a key environmental factor, with transformational leadership outperforming transactional and servant leadership in all aspects. This aligns with Fullan's (2016) view that leaders are drivers of change and shape a learning culture. Qualitative data explain why this director's leadership style is superior. While transactional leadership (common in Linyi) ensures basic obedience through rewards and punishments, it often fosters utilitarian innovation and a fear of failure. In contrast, transformational leadership (prevalent in Weifang) fosters a culture of tolerance for failure and a visionary appeal.

A key finding of this study is the selective effect of educational qualifications. While higher qualifications significantly predict teachers' knowledge and innovation, they do not have a significant main effect on teacher behavior itself. However, high-quality behavior is a skill acquired through in-service practice and mentorship, independent of initial degrees. Hargreaves and Fullan (2012) argue that professional capital relies more on social collaboration than on material assets. Qualitative evidence supports this de-scaling view, with teachers from small

but high-performing kindergartens emphasizing that a cohesive team culture and a positive learning environment are far more important than hardware facilities.

This study provides reliable empirical evidence from Shandong, China, the key factors for the professional development of preschool teachers were identified. Professional development comprises high-frequency training and transformational leadership; training ensures continuous updating of knowledge and behavior, while transformational leadership creates psychological safety and motivation for innovation. To shift from quantity to quality, education stakeholders must refocus from building larger schools and demanding higher qualifications to establishing high-frequency training systems and cultivating transformational leaders.

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