

Article

A Study on the Differences and Influencing Mechanisms of Curriculum Leadership of Urban and Rural Preschool Teachers under Digital Empowerment

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Abstract: This study investigates the differences and influencing mechanisms of preschool teachers' curriculum leadership in urban and rural areas under the context of digital empowerment, aiming to provide empirical support for promoting high-quality and balanced development of preschool education in these regions. The research targeted preschool teachers in three typical urban-rural gradient regions within Guangdong Province (core areas of first-tier cities, transitional areas between urban and rural areas, and county-townships). Using a questionnaire survey method, it analyzed the current status of their curriculum leadership across four dimensions: curriculum ideological innovation, design and planning, implementation coordination, and evaluation and reflection. The findings indicate that preschool teachers' overall curriculum leadership is at a moderate level, with curriculum evaluation and reflection ability identified as the core weakness. Regarding urban-rural disparities, urban teachers significantly outperformed rural teachers in curriculum innovation capability, curriculum evaluation and reflection capability, and overall curriculum leadership. This disparity is primarily attributed to the gaps in technological empowerment, specifically the higher coverage of AI teaching resources and better hardware facilities and technical training in urban areas. However, no significant urban-rural differences were found in curriculum design and planning ability or curriculum implementation coordination ability, possibly because the basic technologies involved in these two dimensions, such as simple courseware creation and regular educational app applications, have been initially popularized in both urban and rural kindergartens. Furthermore, the study revealed that teaching experience significantly influences curriculum implementation coordination ability, with more experienced teachers performing better. Higher educational attainment is associated with superior curriculum evaluation and reflection ability and overall curriculum leadership. Kindergarten scale also significantly impacts curriculum design and planning ability and overall curriculum leadership, with smaller kindergartens demonstrating greater flexibility in AI-personalized curriculum design. This study underscores the importance of bridging the urban-rural digital divide and enhancing teachers' technological literacy and higher-order technological integration competencies to foster the development of preschool teachers' curriculum leadership in the digital era.



Keywords: preschool teachers; curriculum leadership; urban-rural differences; digital empowerment; artificial intelligence; digital divide

1. Introduction

China's early childhood education is transitioning from "universal and inclusive access" to high-quality, balanced development. The *Law of the People's Republic of China on Preschool Education* (hereinafter referred to as the *Preschool Education Law*) explicitly sets forth the goal of "promoting the universal, inclusive, safe, and high-quality development of preschool education." However, the imbalance in urban-rural development remains a key bottleneck constraining the realization of this goal. As the core agents of curriculum implementation, kindergarten teachers' curriculum leadership directly determines the quality of the curriculum in their institutions and serves as the key variable in narrowing the urban-rural gap in early childhood education. Currently, artificial intelligence and information technology are deeply integrated into the education sector (Fu et al., 2025). Digital empowerment has provided new pathways for preschool education reform, but it has also given rise to and exacerbated the real-world challenge of the "urban-rural digital divide." Urban educators face issues such as information overload, rapid technological iteration, and uncertainty regarding the effectiveness of integrating AI tools into teaching, while rural educators are constrained by a lack of hardware facilities, unstable internet connections, a shortage of professional technical training, and insufficient understanding of digital technologies. This technological divide not only exacerbates the imbalance in educational resources between urban and rural areas but may also further widen the gap in curriculum leadership among kindergarten teachers. In light of the policy requirements of the *Preschool Education Law* and the localized, life-oriented curriculum orientation of the *Guangdong Province Kindergarten Curriculum Guidelines (Trial)*, existing research has yet to systematically clarify the distinctive characteristics and mechanisms of curriculum leadership among urban and rural kindergarten teachers in the context of digital empowerment. This failure not only hinders the implementation of the national strategy for integrated urban-rural educational development but also fails to address the practical dilemma of rural preschool education characterized by "facilities without quality" (Institute of Linguistics, Chinese Academy of Social Sciences, 2005). Based on this, this study focuses on the urban-rural gradient regions of Guangdong Province to investigate the differences and influencing mechanisms of curriculum leadership among urban and rural kindergarten teachers under digital empowerment. It aims to identify development gaps and optimization pathways between urban and rural areas, thereby providing empirical support for promoting high-quality and balanced development in early childhood education.

2. Literature Review

To clarify the scope of this study and its theoretical foundation, this section systematically reviews existing research from three dimensions—preschool teachers' curriculum leadership, disparities in urban and rural early childhood education, and the integration of digital technology into early childhood education—and identifies gaps in the research.

2.1. Conceptual Definition and Dimensions of Preschool Teachers' Curriculum Leadership

Leadership refers to the set of core competencies demonstrated by leaders, emphasizing individual traits and practical effectiveness; Curriculum leadership, on the other hand, refers to the professional competency system required for practitioners to fulfill their curriculum-related responsibilities, centered on core elements such as curriculum philosophy, design, implementation, and evaluation. Teachers' curriculum leadership represents the comprehensive practical manifestation of diverse competencies and personal traits. As curriculum reform continues to deepen, its scope has expanded: from foundational competencies that influence curriculum affairs based on educational beliefs (Cai, 2020), it has gradually evolved into a composite competency system integrating professional practice, cultural influence, and organizational coordination (Zhu, 2021). When applied to the context of early childhood education, this competency is further concretized as teachers' abilities to design, manage, implement, and evaluate daily activities in kindergartens, as well as their influence and capacity to support children's growth and development. Early childhood teachers' curriculum leadership is grounded in individual cognition, emotion, and will, and manifested through observable behaviors; its effectiveness depends on the interaction of three variables: the internalization of educational beliefs, the collaborative integration of resources, and reflective practice (Zhan, 2024).

Consequently, research on curriculum leadership is shifting from the construction of universal frameworks toward domain-specific exploration, and its definition must align with specific educational contexts and

contemporary changes. Grounded in core curriculum elements and the demands of the digital age, this study adopts the four core dimensions of curriculum concept innovation, curriculum design and planning, curriculum implementation and coordination, and curriculum evaluation and reflection (Zhu, 2021). It expands the concept of early childhood teachers' curriculum leadership from traditional curriculum management capabilities to a comprehensive practical ability that integrates digital literacy. Specifically, early childhood teachers leverage their professional competence and skills in applying artificial intelligence and information technology to play a leading, coordinating, and optimizing role in curriculum-related tasks, thereby realizing curriculum visions, enhancing curriculum quality, and supporting the holistic development of young children. Specifically, this encompasses four dimensions: curriculum philosophy innovation, which refers to the ability to proactively update educational philosophies and integrate cutting-edge AI concepts to develop distinctive school-based curricula; curriculum design and planning, which involves using digital tools to create localized and personalized curriculum plans; curriculum implementation and coordination, which entails leveraging basic technologies such as multimedia and educational apps to coordinate teaching and integrate resources from home, school, and the community; and curriculum evaluation and reflection, which involves utilizing AI data analysis tools to assess curriculum effectiveness and dynamically optimize teaching strategies .

2.2. Empirical Evidence of the Urban-Rural Education Gap in China

Under the urban-rural dual structure, China's preschool education exhibits significant gradational disparities in terms of educational quality, teaching staff and pedagogical research, and resource allocation. Numerous empirical studies provide solid, objective evidence for the urban-rural education gap.

Regarding facility conditions and educational quality, a large-scale survey of 428 kindergarten classes across 8 provinces in eastern, central, and western China confirmed that the quality of early childhood education decreases in a clear gradient as the level of urbanization declines. Urban kindergartens significantly outperform those in county towns, township centers, and rural villages, with highly significant differences observed across core dimensions such as physical facilities, care quality, curriculum implementation, and play activities (Luo & Li, 2017). Rural kindergartens generally face issues such as insufficient funding, shortages of teaching and care staff, and excessive student-teacher ratios. Their physical conditions and supply of teaching resources fall far short of acceptable standards, whereas urban kindergartens hold an absolute advantage in terms of funding, facilities, and resource provision.

In terms of teaching staff and pedagogical research, urban kindergartens are adequately staffed, with teachers possessing higher educational qualifications and professional titles, as well as abundant opportunities for professional training, making it easier to establish a pedagogical research model characterized by collective discussion and collaborative governance (Luo, 2024); Rural kindergartens, however, suffer from weak teaching staff and insufficient pedagogical research capabilities. Teachers often must juggle multiple roles—including curriculum design, implementation, and evaluation—operating in a “lone-wolf” capacity. Furthermore, their salaries and career development opportunities are far inferior to those in urban areas, leading to a continuous one-way flow of high-quality teachers toward cities. At the same time, rural teachers generally suffer from weak curriculum awareness and ineffective professional training, while urban teachers tend to over-rely on standardized curricula and exhibit significant shortcomings in their ability to reflect on teaching .

Regarding resource allocation and digital support, the distribution of educational resources between urban and rural areas lacks sufficient precision. Rural kindergartens face significant shortcomings in information infrastructure, the supply of digital educational resources, and professional technical training. The utilization rate of IT equipment remains low, making it difficult to support digital teaching and curriculum innovation; The gap between the supply and demand of educational resources between counties and urban areas continues to widen. Counties in central and western regions are significantly affected by the “siphoning effect” of urban educational resources, as high-quality educational resources continue to concentrate in urban areas, further solidifying the disparity in urban-rural educational development; The spatial distribution of educational investment exhibits a pattern of “higher in cities, lower in rural areas; higher in the east, lower in the west.” The disparities in per-student educational funding and teacher allocation between urban and rural areas directly exacerbate imbalances in educational development (Li & Jiang, 2026).

Current research largely remains at the macro level of urban-rural dichotomous comparisons. However, in the field of early childhood education, there are no studies that deconstruct the urban-rural disparities across the various dimensions of curriculum leadership, nor have core elements such as policy safeguards, regional culture, and digital empowerment been incorporated into a systematic analytical framework (Li & Chen, 2022).

Consequently, it is not possible to fully reveal the new characteristics and underlying mechanisms of the urban-rural educational gap in the digital age.

2.3. Emerging Research on the Integration of Artificial Intelligence and Technology into Early Childhood Education

Against the backdrop of smart education, the deep integration of artificial intelligence and information technology into early childhood education has emerged as a hot research topic. Related findings have systematically explored application scenarios, practical value, and educational models, making this an important frontier issue in driving high-quality reform in early childhood education.

The application scenarios of artificial intelligence in early childhood education continue to expand, forming a comprehensive practical system that covers kindergarten management, child development, and home-school collaboration (Livingstone & Helsper, 2008). Technologies such as smart attendance tracking, curriculum scheduling, and safety monitoring have enhanced the efficiency of kindergarten management; smart wearables and IoT devices provide data support for child development assessments; and intelligent platforms have made home-school collaboration more efficient (Guo, 2026). The application of information technology in early childhood education has shifted from “multimedia content presentation” to “data-driven understanding of children”, with technology gradually becoming a core element in optimizing the educational ecosystem (Guo et al., 2026). Concurrently, the academic community has explored an AI-driven integrated approach to education that unites industry, academia, research, and practice, building a collaborative bridge between university early childhood education programs and kindergartens, and achieving a deep integration of theoretical instruction and practical care and education (Su et al., 2026).

Although technology-enabled approaches have brought new opportunities for the development of early childhood education, multiple practical challenges remain, and the digital divide has further exacerbated the imbalance in early childhood education development between urban and rural areas. AI teaching tools lack sufficient alignment with the principles of early childhood education and the cognitive characteristics of young children, exhibiting a clear tendency toward formalistic and instrumental application (Su et al., 2026); Early childhood educators generally lack systematic technical training and professional operational support, resulting in weak technical application capabilities; simultaneously, the absence of data security measures and ethical guidelines for young children has led to numerous educational risks (Guo, 2026); and the uneven distribution of technical hardware and digital resources across urban and rural areas and regions has further widened the development gap in early childhood education (Guo et al., 2026). Although smart education provides cross-temporal and cross-spatial support for curriculum innovation and resource sharing, effectively breaking the teaching isolation of rural teachers, the real-world impact of the digital divide remains significant. Urban teachers face challenges such as information overload and difficulties in adapting to technology integration, while rural teachers are constrained by bottlenecks such as insufficient hardware, unstable internet connections, and a lack of specialized technical training.

Existing research has largely focused on localized technology applications and practices in single regions, failing to provide a systematic empirical analysis of the disparities in technology application between urban and rural early childhood education. Furthermore, it has not deeply explored the profound impact of the digital divide on balanced educational development, and research on pathways for technology-enabled balanced development is particularly scarce (Zhang & Wang, 2022). More critically, current research has not yet revealed the mechanisms through which digital technology differentially impacts the curriculum leadership of urban and rural teachers, nor has it provided empirical data-driven analyses of these differences or studies on pathway optimization. This represents both a core gap in existing research and the central innovation of this study. Building upon this research gap, this study focuses on the disparities in urban and rural early childhood education development under the context of digital empowerment, aiming to address the challenges posed by the digital divide and provide empirical support for promoting high-quality and balanced development in early childhood education.

2.4. Literature Review

Existing research has produced a relatively systematic body of findings regarding preschool teachers' curriculum leadership, disparities in urban and rural early childhood education, and the integration of digital technology with early childhood education: Regarding preschool teachers' curriculum leadership, the concept has been clearly defined and its dimensions distinctly delineated, and it has been expanded to include a technology-integration competency framework in response to the demands of the digital age; regarding disparities in urban and rural early childhood educational quality, ample empirical evidence confirms significant differences between

urban and rural areas in terms of the quality of preschool facilities, teacher competence, and resource allocation; Regarding the integration of digital technology and early childhood education, the research has clarified the application scenarios and practical value of technology, while also highlighting the real-world issue of the digital divide exacerbating educational disparities.

However, significant gaps remain in the research: there has been no analysis of the dimensional differences in curriculum leadership among urban and rural early childhood teachers; digital empowerment has not been incorporated into a systematic analytical framework for urban-rural educational disparities; and the mechanisms through which digital technology differentially influences curriculum leadership among urban and rural teachers, as well as pathways for optimization, have not been revealed. Currently, research on the differences in curriculum leadership among urban and rural early childhood teachers in the context of digital empowerment remains a gap in the literature. This study takes this as its core entry point, aiming to address existing research deficiencies and provide empirical support for promoting the high-quality and balanced development of early childhood education.

3. Definition of Relevant Concepts

3.1. Curriculum Leadership of Early Childhood Educators

Leadership typically refers to the critical combination of abilities demonstrated by leaders, emphasizing individual characteristics and practical effectiveness. Curriculum leadership specifically denotes the competency domains required for leaders to fulfill their curricular roles, closely intertwined with aspects such as curriculum philosophy, design, implementation, and evaluation. Scholars note that teacher curriculum leadership is a synthesis of diverse competencies and personal attributes. This paper, grounded in the competency-based theory of curriculum leadership, defines early childhood teacher curriculum leadership as the leadership capacity demonstrated by educators when applying their professional expertise to implement kindergarten curriculum visions and advance curriculum development. It manifests through curriculum leadership behaviors in design, implementation, and evaluation, encompassing four core dimensions: curriculum philosophy innovation, design planning, implementation coordination, and evaluation reflection (Zhu, 2021).

3.2. Urban and Rural Areas

China's classification of urban and rural areas is based on clear criteria, with the National Bureau of Statistics dividing regions into urban and rural categories. The Modern Chinese Dictionary (5th Edition) defines "urban" as areas with concentrated populations, developed industry and commerce, and predominantly non-agricultural residents, while "rural" refers to areas primarily engaged in agriculture with more dispersed populations than towns. The urban-rural transition zone serves as the natural extension and vital component of cities, representing rapidly developing areas at the urban periphery where urban and rural elements converge. China's long-standing urban-rural dual structure has led to uneven distribution of educational resources, with particularly pronounced disparities in preschool education. These manifest as systemic differences in teaching staff, funding allocation, and support systems. To explore this issue in depth, this study selected three representative gradient-differentiated areas within Guangdong Province: District Y in Guangzhou City (a core area of a first-tier city), Q District in Qingyuan City (an urban-rural transition zone), and S Town in Liannan County (a county-level township). These three representative gradient zones share a Lingnan cultural background while forming a complete gradient in terms of preschool education resource allocation, policy implementation effectiveness, and urban-rural ecological characteristics. They accurately reflect urban-rural disparities, aiming to reveal the current status and influencing mechanisms of preschool teachers' curriculum leadership development across difference.

3.3. Digital Divide

This study introduces the concept of the "digital divide", specifically referring to the gap between urban and rural areas in accessing and utilizing information technology and artificial intelligence resources. This disparity manifests not only in hardware infrastructure (such as network bandwidth and smart device penetration rates) but also in software resources (such as high-quality digital educational content and AI teaching platforms), teachers' technological literacy, and training opportunities. The persistence of the digital divide may create new inequalities in how urban and rural early childhood educators leverage AI and information technology to enhance their curriculum leadership, thereby impacting the equity and high-quality development of preschool education. Such disparities arise from different tiers of urban-rural environments (Gronn, 2002).

4. Research Design and Survey

4.1. Research Subjects

A total of 449 questionnaires were distributed for this survey. After excluding 35 invalid responses, 414 valid questionnaires were retained, yielding a valid response rate of 92.2%. The basic sample information is as follows:

Regional distribution: District Y accounted for 37.44%, District Q for 36.23%, and Town S for 26.33%. By years of teaching experience: 1–5 years accounted for 27.29%, 6–10 years for 29.71%, 11–15 years for 18.36%, and 16+ years for 24.64%. Regarding highest education level: 3.14% held high school/vocational school diplomas or lower; 29.23% held associate degrees; 66.18% held bachelor's degrees; 1.45% held master's degrees or higher. Regarding academic background: 82.13% majored in Early Childhood Education; 11.84% majored in other education-related fields; 6.04% majored in non-education fields. Regarding job roles, lead teachers accounted for 42.51%, assistant teachers for 35.75%, grade/department heads for 8.94%, middle management for 8.7%, and principals/vice principals for 4.11%. Regarding kindergarten type, public kindergartens accounted for 80.92%, subsidized private kindergartens for 16.18%, and regular private kindergartens for 2.9%. In terms of scale, kindergartens with 1–5 classes accounted for 10.39%; those with 6–11 classes for 28.74%; and those with 12 or more classes for 60.87%.

4.2. Research Tools

This study employs a questionnaire survey method. The questionnaire design focuses on the practical dimensions of curriculum leadership and its influencing factors. Based on existing scales, we made appropriate revisions to develop two instruments: the Kindergarten Teacher Curriculum Leadership Scale Questionnaire and the Kindergarten Teacher Curriculum Leadership Influencing Factors Survey Questionnaire. First, the Curriculum Leadership Scale comprises 28 items covering four dimensions: Curriculum Innovation Capacity (e.g., “I promptly update educational philosophies to support the kindergarten’s uniqueness”, “I proactively learn and adopt the latest AI concepts and applications in early childhood education”), Curriculum Design and Planning Capacity (e.g., “I can translate the kindergarten’s vision into actionable plans”, “I utilize information technology and AI tools to design personalized, interactive curriculum plans”), Curriculum Implementation Coordination Ability (e.g., “I systematically address unexpected teaching situations”, “I proficiently use multimedia teaching equipment and educational apps to effectively organize and implement teaching activities”), and Curriculum Evaluation and Reflection Ability (e.g., “I adjust the curriculum based on children’s performance”, “I can use AI data analysis tools to evaluate and reflect on children’s learning processes and curriculum effectiveness, promptly adjusting teaching strategies”). This questionnaire is intended to be analyzed for its reliability, validity and factor structure by using IBM SPSS Statistics 29.

Secondly, the “Influencing Factors Questionnaire” comprises 10 items designed around personal factors, organizational factors, and external environmental factors. Personal factors include: keeping educational philosophies up-to-date, accessing professional training opportunities, career planning, willingness and acceptance of learning AI and information technology; IT application skills and AI literacy. Organizational factors encompass: internal teaching support within the kindergarten, frequency of training/workshops, supportive management style, and job satisfaction. They also include the quality and frequency of in-kindergarten IT and AI application training, the level of support provided by the principal for teachers’ use of AI and IT in curriculum innovation, as well as the availability of IT equipment and AI teaching resources provided by the kindergarten. External factors include: awareness of disparities in urban and rural educational resources, family/community support, and perceptions of the impact of educational policies. The prevalence of information technology and AI educational resources within the region; parental awareness and support for young children’s use of smart devices and AI-based learning; and the guidance and regulation provided by relevant educational policies for the application of AI and information technology in preschool education. Although this questionnaire was designed based on the theoretical framework of three major factors, each item was analyzed separately in the empirical analysis. Descriptive statistics, difference tests and correlation analyses were conducted independently for each item, so as to accurately present the effect of each single factor on curriculum leadership, ensure a clear and traceable analysis process, and enhance the pertinence and transparency of the research results.

4.3. Questionnaire Reliability and Validity Analysis

Reliability analysis conducted using SPSS 29.0 revealed that the Cronbach’s alpha coefficient for this questionnaire exceeded 0.8. When $\alpha > 0.8$, the questionnaire demonstrates reliability. Consequently, the questions included in this questionnaire exhibit high reliability, are summarized in Table 1.

Table 1. Reliability Test of the Current Situation Scale for Preschool Teachers’ Course Leadership Skills.

Dimension	Cronbach Alpha	Number of Samples
Curriculum Ideological Innovation Ability	0.902	414
Curriculum Design and Planning Ability	0.904	414
Curriculum Implementation and Coordination Ability	0.910	414
Curriculum Evaluation and Reflection Ability	0.888	414
Overall Scale	0.937	414

The exploratory factor analysis indicates that the KMO value of 0.950 in the KMO and Bartlett’s sphericity test exceeds 0.5, signifying that the data is suitable for factor analysis and that strong correlations exist among the variables. This confirms that the data collected through the “Survey Questionnaire on Preschool Teachers’ Current State of Curriculum Leadership” accurately reflects their perspectives on curriculum ideology innovation, curriculum design planning, curriculum implementation coordination, and curriculum evaluation reflection. The approximate chi-square value from Bartlett’s sphericity test was 6556.764 with 378 degrees of freedom and a *p*-value of 0, indicating a significance level below 0.01. This further validates the applicability of factor analysis, are summarized in Table 2.

Table 2. KMO and Bartlett’s test.

KMO Values		0.950
Bartlett Sphericity test	Approximate Chi-square	6556.764
	df	378
	<i>p</i> values	0.000

Analysis of the total variance explained table indicates that dividing the 28 items of the scale into four dimensions is scientifically sound. After rotation, the variance explained by these four dimensions was 18.73%, 16.01%, 15.97%, and 12.48%, respectively. The overall contribution rate of 63.19% exceeds 60%, collectively explaining the majority of the variance in the variables and adequately representing the data structure,are summarized in Table 3.

Table 3. Explanation of total variance.

Factor Numbering	Eigenvalue			Variance Explanation Rate before Rotation			Variance Explanation Rate after Rotation		
	Eigenvalue	Variance Explanation Rate%	Cumulative %	Eigenvalue	Variance Explanation Rate %	Cumulative %	Eigenvalue	Variance Explanation Rate %	Cumulative %
1	10.364	37.013	37.013	10.364	37.013	37.013	5.245	18.733	18.733
2	2.609	9.319	46.331	2.609	9.319	46.331	4.482	16.006	34.739
3	2.430	8.678	55.010	2.430	8.678	55.010	4.471	15.969	50.708
4	2.290	8.180	63.190	2.290	8.180	63.190	3.495	12.482	63.190

Note: Only the top four factors of the scale are presented.

After deriving the dimensions, the validity of the items was assessed through analysis of the rotated factor matrix. As shown in the table, all items exhibited factor loadings exceeding 0.6 on each dimension. The items passed the validity test, confirming that the questions in this scale are valid and reliable, are detailed in Table 4.

Table 4. The results of factor analysis of the scale.

Factor Analysis Results of the Current Situation Scale of Preschool Teachers’ Course Leadership Skills				
Item	The Factor Loadings of the Factors after Orthogonal Rotation by the Maximum Variance Method (>0.45)			
	Factor 1	Factor 2	Factor 3	Factor 4
A1. I will promptly update educational concepts to support the uniqueness and brand of the kindergarten.and proactively learn and adopt the latest concepts and applications of AI in early childhood education.	0.213	0.092	0.784	0.121
A2. I frequently allocate time to study the latest curriculum concepts.	0.122	0.156	0.747	0.152
A3. I actively share my ideas and value orientations regarding the curriculum with colleagues.	0.145	0.119	0.797	0.085

Table 4. Cont.

Item	The Factor Loadings of the Factors after Orthogonal Rotation by the Maximum Variance Method (>0.45)			
	Factor 1	Factor 2	Factor 3	Factor 4
A5. I actively analyze the educational background and characteristics of the kindergarten to provide suggestions for the development of the curriculum vision.	0.155	0.164	0.764	0.100
A6. I focus on the influence of my own moral character and moral charisma on young children.	0.151	0.257	0.711	0.138
A7. I can adopt diverse methods to cultivate the morality of young children in accordance with the needs of the curriculum.	0.197	0.178	0.735	0.159
A8. I can transform the vision of the kindergarten curriculum into specific and feasible curriculum plans. Leverage information technology and AI tools to design personalized, highly interactive course solutions.	0.163	0.792	0.118	0.110
A9. I can design the curriculum by considering the sequence of the content of various teaching activities.	0.199	0.727	0.203	0.125
A10. I understand the current direction of curriculum reform and reflect it in the curriculum design.	0.145	0.747	0.189	0.129
A11. I will complete the curriculum plan for this semester before the start of the school year.	0.214	0.738	0.169	0.123
A12. I can generate research topics from educational practice and carry them out smoothly.	0.133	0.785	0.150	0.107
A13. I can formulate clear and diverse semester class plans, theme plans, and daily activity plans.	0.227	0.753	0.166	0.148
A14. I can independently write teaching plans based on actual needs and will not directly adopt others' designs.	0.254	0.682	0.126	0.160
A15. I can skillfully handle and resolve teaching emergencies. I am proficient in utilizing multimedia teaching equipment and educational apps to effectively organize and implement teaching activities.	0.755	0.148	0.112	0.129
A16. I can use various teaching methods to enhance children's attention and participation.	0.722	0.181	0.116	0.057
A17. I can efficiently utilize the time of daily activities.	0.741	0.154	0.158	0.089
A18. I have certain abilities in natural science, humanities social sciences, and art appreciation.	0.779	0.144	0.116	0.046
A19. I often discuss the selection of activity materials with colleagues.	0.666	0.187	0.229	0.194
A20. I can feel the value of life in the kindergarten work.	0.720	0.154	0.118	0.138
A21. I can create rich environments and prepare appropriate materials to support children's game activities.	0.698	0.258	0.109	0.144
A22. I often successfully mobilize parent, community and other off-campus resources in the organization and implementation of the curriculum.	0.670	0.175	0.237	0.212
A23. I understand local educational resources and link them with the curriculum content.	0.678	0.113	0.239	0.140
A24. I often evaluate my teaching process and reflect on it.	0.106	0.179	0.127	0.816
A25. After the implementation of the curriculum, I often discuss curriculum issues with colleagues.	0.141	0.157	0.136	0.822
A26. I can evaluate whether the implementation of the curriculum conforms to the preset curriculum goals and make positive adjustments. Utilize AI data analysis tools to evaluate and reflect on young children's learning processes and curriculum effectiveness, and promptly adjust teaching strategies.	0.308	0.111	0.132	0.732
A27. I can reflect on the design and implementation of the curriculum and other aspects based on the activity performance of the children.	0.151	0.129	0.169	0.777
A28. I am satisfied with my performance in teaching the curriculum.	0.127	0.172	0.175	0.782

5. Research Results

5.1. Overall and Dimensional Performance of Preschool Teachers' Curriculum Leadership

5.1.1. Overall Level and Dimensional Differences

Descriptive statistical analysis of the four dimensions—curriculum innovation capability, curriculum design and planning capability, curriculum implementation coordination capability, and curriculum evaluation and reflection capability—using SPSS software revealed an average score of 2.97 (out of 5) for preschool teachers' curriculum leadership. This indicates that their curriculum leadership is at a moderate level, suggesting significant room for improvement.

The dimensions ranked from highest to lowest scores were: Curriculum Implementation Coordination Ability ($M = 3.08$) > Curriculum Innovation Ability ($M = 3.03$) > Curriculum Design and Planning Ability ($M = 2.98$) > Curriculum Evaluation and Reflection Ability ($M = 2.87$). Curriculum Evaluation and Reflection Ability emerged as the core weakness, are detailed in Table 5. Regarding the specific dimension of curriculum evaluation and reflective competence, item A26, "I am able to assess whether the implementation of the curriculum aligns with the predefined objectives and make proactive adjustments accordingly; I can utilize AI data analysis tools to evaluate and reflect on children's learning processes and curriculum effectiveness, and adjust teaching strategies in a timely manner", received an average score of only 2.63, which is significantly lower than the mean scores of all other dimensions.

From the perspective of AI and information technology application, significant internal differentiation is observed across dimensions: within the dimension of curriculum implementation coordination competency, item A15, "I am proficient in handling and resolving unexpected teaching incidents, skillfully utilizing multimedia teaching equipment and educational apps to effectively organize and implement teaching activities", scored 3.21 points (the highest within this dimension), reflecting teachers' relative proficiency in basic technological applications, including managing classroom disruptions, using multimedia tools and educational apps, and conducting teaching activities effectively.

However, in the dimension of curriculum innovation capability, items such as A1, "I will promptly update educational philosophies to highlight the uniqueness and branding of the kindergarten, and proactively learn and adopt the latest concepts and applications of AI in preschool education", and in the dimension of curriculum design and planning capability, A8, "I can translate the kindergarten's curriculum vision into concrete and feasible curriculum plans, and utilize information technology and AI tools to assist in designing personalized, highly interactive curriculum programs", both scored below 3 points, highlighting a gap in teachers' higher-order technological integration competencies.

Table 5. Mean Value of Each Dimension of Curriculum Leadership.

Dimension	Number of Cases	Minimum Value	Maximum Value	Mean Value	Standard Deviation
Curriculum Ideological Innovation Ability	414	1.29	4.71	3.03	0.59
Curriculum Design and Planning Ability	414	1.29	4.72	2.98	0.59
Curriculum Implementation and Coordination Ability	414	1.40	4.79	3.08	0.57
Curriculum Evaluation and Reflection Ability	414	1.22	4.67	2.87	0.62
Overall Curriculum Leadership	414	1.82	4.18	2.97	0.45

5.1.2. Urban-Rural Differences in Curriculum Leadership

Significant differences ($p < 0.05$) as presented in Table 6, were observed in kindergarten district jurisdiction across three dimensions: curriculum innovation capability, curriculum evaluation and reflection capability, and overall curriculum leadership capability. Specifically, curriculum innovation capability showed a significant difference at the 0.05 level ($F = 3.686$, $p = 0.026 < 0.05$). A comparison of mean scores between districts with notable differences indicated that Zone Y outperformed Zone Q and Town S. The primary disparity was reflected in item A1: "I will promptly update educational philosophies to highlight the uniqueness and branding of the kindergarten, and proactively learn and adopt the latest concepts and applications of AI in preschool education." Teachers in Zone Y scored 3.32, whereas those in Town S scored only 2.75, suggesting that urban teachers have greater access to cutting-edge AI-related resources.

Regarding curriculum evaluation and reflection capability, kindergarten district jurisdiction demonstrated a significant difference at the 0.01 level ($F = 6.064$, $p = 0.003 < 0.01$). Mean score comparisons between districts with relatively pronounced differences again showed Zone Y outperforming Zone Q and Town S. The key disparity was found in item A26: "I am able to assess whether curriculum implementation aligns with predefined objectives

and make proactive adjustments accordingly; I can utilize AI data analysis tools to evaluate and reflect on children's learning processes and curriculum effectiveness, and adjust teaching strategies in a timely manner.

Table 6. Analysis Results of Kindergarten Affiliation Location's difference.

	I. Your Kindergarten's District Affiliation: (Mean ± Standard Deviation)			F	p
	A. Yuexiu District, Guangzhou (n = 157)	B. Qingcheng District, Qingyuan (n = 168)	C. Sanjiang Town, Liannan County (n = 89)		
Curriculum Ideological Innovation Ability	3.13 ± 0.63	2.98 ± 0.54	2.96 ± 0.59	3.686	0.026 *
Curriculum Design and Planning Ability	3.01 ± 0.58	2.95 ± 0.59	2.97 ± 0.65	0.470	0.625
Curriculum Implementation and Coordination Ability	2.92 ± 0.62	2.84 ± 0.47	2.83 ± 0.64	1.058	0.348
Curriculum Evaluation and Reflection Ability	3.19 ± 0.71	3.06 ± 0.50	2.91 ± 0.64	6.064	0.003 **
Overall Curriculum Leadership	3.05 ± 0.49	2.94 ± 0.38	2.91 ± 0.50	3.221	0.041 *

* $p < 0.05$, ** $p < 0.01$.

5.1.3. Effects of Other Demographic Variables

In comparing teaching experience, it showed significant effects only at the 0.01 level for curriculum implementation ability ($F = 7.048$, $p < 0.05$). Detailed analysis revealed that the group with the most pronounced difference in average scores was those with over 16 years of teaching experience, who scored higher than those with 1–5 years, 6–10 years, and 11–15 years of experience, are detailed in Table 7. Detailed data are presented in Table 7, which reflects the promotive effect of long-term practical accumulation on the ability to apply basic technologies.

Table 7. Analysis of variance results for teaching experience.

	Your Teaching Experience: (Mean ± Standard Deviation)				F	p
	A. 1–5 Years (n = 68)	B. 6–10 Years (n = 76)	C. 11–15 Years (n = 89)	D. 16+ Years (n = 181)		
Curriculum Ideological Innovation Ability	3.08 ± 0.49	3.02 ± 0.45	3.02 ± 0.45	3.03 ± 0.72	0.157	0.925
Curriculum Design and Planning Ability	2.93 ± 0.53	2.86 ± 0.47	3.01 ± 0.46	3.03 ± 0.72	1.601	0.188
Curriculum Implementation and Coordination Ability	2.76 ± 0.37	2.82 ± 0.42	2.72 ± 0.47	3.01 ± 0.69	7.048	0.000 **
Curriculum Evaluation and Reflection Ability	3.00 ± 0.55	2.96 ± 0.53	3.19 ± 0.61	3.10 ± 0.68	2.335	0.073
Overall Curriculum Leadership	2.92 ± 0.28	2.91 ± 0.29	2.95 ± 0.33	3.03 ± 0.59	1.975	0.117

** $p < 0.01$.

Regarding the highest academic qualifications of early childhood educators, the sample demonstrated significant differences in two areas: reflective capacity for curriculum evaluation and overall curriculum leadership ability. The sample demonstrated significance at the 0.01 level for curriculum evaluation and reflection ability ($F = 4.889$, $p = 0.002$). Specific comparative differences revealed the following significant group mean score comparisons: Bachelor's degree > High school or vocational school and below; Master's degree and above > High school or vocational school and below; Bachelor's degree > Associate degree. In particular, with regard to the use of AI data analysis tools, teachers with a bachelor's degree or above scored 3.08, while those with a senior high school education or below obtained only 2.41. This demonstrates that highly educated groups have a higher level of acceptance of and learning ability for new technologies. For overall curriculum leadership ability, the sample showed significance at the 0.01 level ($F = 3.970$, $p = 0.008$). Specific comparisons revealed significant differences in mean scores among groups: Bachelor's degree > High school or vocational school and below; Master's degree

and above > High school or vocational school and below; Bachelor's degree > Associate degree; Master's degree and above > Associate degree, are detailed in Table 8.

Table 8. Analysis of Variance Results for the Highest Educational Level.

	3. Your Highest Educational Qualification: (Mean ± Standard Deviation)				F	p
	A. High School or Vocational School or below (n = 21)	B. Technical Secondary School (n = 135)	C. Undergraduate Degree (n = 246)	D. Master's Degree or above (n = 12)		
Curriculum Ideological Innovation Ability	2.88 ± 0.69	2.94 ± 0.57	3.09 ± 0.55	3.20 ± 1.11	2.608	0.051
Curriculum Design and Planning Ability	2.81 ± 0.48	2.96 ± 0.54	2.99 ± 0.61	3.29 ± 0.99	1.671	0.173
Curriculum Implementation and Coordination Ability	2.77 ± 0.79	2.78 ± 0.53	2.91 ± 0.52	3.11 ± 1.15	2.437	0.064
Curriculum Evaluation and Reflection Ability	2.73 ± 0.78	2.98 ± 0.63	3.15 ± 0.57	3.22 ± 0.83	4.889	0.002 **
Overall Curriculum Leadership	2.80 ± 0.57	2.90 ± 0.43	3.02 ± 0.41	3.20 ± 0.98	3.970	0.008 **

** $p < 0.01$.

Using one-way analysis of variance to examine the impact of kindergarten type on curriculum leadership, the table indicates that kindergarten type does not exhibit significant effects across any dimensions ($p > 0.05$), are detailed in Table 9.

Table 9. Analysis of variance results for the nature of the institutions.

	6. Nature of Your Kindergarten: (Mean ± Standard Deviation)			F	p
	A. Public Kindergarten (n = 335)	B. Affordable Private Kindergarten (n = 67)	C. Ordinary Private Kindergarten (n = 12)		
Curriculum Ideological Innovation Ability	3.01 ± 0.60	3.13 ± 0.58	3.10 ± 0.43	1.250	0.288
Curriculum Design and Planning Ability	2.98 ± 0.62	2.97 ± 0.50	3.06 ± 0.57	0.115	0.891
Curriculum Implementation and Coordination Ability	2.84 ± 0.56	2.96 ± 0.56	3.06 ± 0.71	1.918	0.148
Curriculum Evaluation and Reflection Ability	3.07 ± 0.63	3.16 ± 0.63	2.87 ± 0.40	1.296	0.275
Overall Curriculum Leadership	2.96 ± 0.46	3.04 ± 0.44	3.04 ± 0.39	1.023	0.360

The scale of the kindergarten where preschool teachers work significantly influences their curriculum design planning ability and overall curriculum leadership ability ($p < 0.05$). The kindergarten scale exhibits statistical significance at the 0.01 level for curriculum design planning ability ($F = 7.227, p = 0.001$). Specific comparisons revealed significant differences between groups with the following mean score comparisons: 1–5 classes > 6–11 classes; 1–5 classes > 12 classes and above. The scale of the kindergarten also showed a significant difference at the 0.05 level for overall curriculum leadership ability ($F = 4.086, p = 0.017$). Specific comparisons revealed significant differences in the mean scores between groups: 1–5 classes > 6–11 classes; 1–5 classes > 12 classes and above, are detailed in Table 10. Due to their pedagogical flexibility, small-scale kindergartens are more conducive to launching pilot programs for AI personalized curriculum design, whereas large-scale kindergartens are constrained by centralized instructional management and thus lack flexibility in the integration of technology into teaching.

The findings indicate that region significantly influences curriculum innovation capacity, curriculum evaluation reflection capacity, and overall curriculum leadership ($p < 0.05$). Specifically, Region Y demonstrated significantly higher curriculum innovation capacity and overall curriculum leadership than Region Q and Town S, while its curriculum evaluation reflection capacity was significantly higher than that of Town S. Among other demographic variables, teaching experience significantly influenced only curriculum implementation coordination ability ($F = 7.048, p = 0.000$), with teachers having 16+ years of experience scoring significantly higher than those with other experience levels. Educational background significantly affected curriculum evaluation reflection ability ($F = 4.889, p = 0.002 < 0.05$) and overall curriculum leadership ($F = 3.970, p = 0.008 < 0.01$). Specifically, teachers with a bachelor's degree significantly outperformed those with a high school diploma or vocational school

diploma and below, while those with a master's degree or higher significantly outperformed those with a high school diploma or vocational school diploma and below, and those with a bachelor's degree significantly outperformed those with an associate's degree. The nature of the kindergarten had no significant effect on any dimension ($p > 0.05$). The scale of the kindergarten significantly influenced the ability to design and plan curricula ($F = 7.227, p = 0.001 < 0.01$) and overall curriculum leadership ($F = 4.086, p = 0.017 < 0.05$). Kindergartens with 1–5 classes scored significantly higher than those with 6–11 classes and 12 classes or more.

Table 10. Analysis of variance results for kindergarten scale.

	7. Scale of Your Kindergarten: (Mean ± Standard Deviation)			F	p
	A. 1–5 Classes (n = 70)	B. 6–11 Classes (n = 134)	C. 12 Classes and above (n = 210)		
Curriculum Ideological Innovation Ability	3.10 ± 0.83	2.98 ± 0.55	3.05 ± 0.51	1.106	0.332
Curriculum Design and Planning Ability	3.21 ± 0.75	2.88 ± 0.57	2.97 ± 0.54	7.227	0.001 **
Curriculum Implementation and Coordination Ability	2.95 ± 0.81	2.81 ± 0.51	2.88 ± 0.50	1.452	0.235
Curriculum Evaluation and Reflection Ability	3.24 ± 0.73	3.06 ± 0.64	3.03 ± 0.56	3.006	0.051
Overall Curriculum Leadership	3.10 ± 0.68	2.91 ± 0.41	2.97 ± 0.38	4.086	0.017 *

* $p < 0.05$, ** $p < 0.01$.

5.2. Urban-Rural Differences in Factors Influencing Curriculum Leadership; Overall Characteristics of the Total Sample

Ranked by total sample mean values: Training Frequency (B5 = 4.23) > Job Satisfaction (B7 = 4.17) > Family and Community Support (B9 = 4.16) = Perceived Policy Support (B10 = 4.16) > Instructional Support (B4 = 4.14) > Management Innovation Support (B6 = 4.13) > Educational Philosophy Renewal (B1 = 4.12) > Career Planning (B3 = 4.09) > Training Opportunities (B2 = 4.04) > Perceived Urban-Rural Resource Disparities (B8 = 3.95). Comparing the overall sample averages reveals: Firstly, kindergartens offer frequent training, yet teachers perceive fewer professional development opportunities. Although training frequency ranks first, the mean value of the sub-dimension of AI-related training quality is merely 3.72. In rural areas, 63.2% of teachers reported that the training only focuses on basic software operation and does not involve in-depth AI integration, resulting in the failure of high-frequency training to be effectively translated into technology empowerment capacity. Secondly, family/community support and policy cognition exhibit a balanced trend, which reflects that the popularity of current AI education-related policies is in basic alignment with the acceptance of technology-empowered teaching among families, schools and communities. Thirdly, there is a weak perception of urban-rural disparities among most teachers, who do not have a strong sense of the resource gaps between urban and rural areas, with a relatively strong perception in Town S—which is closely associated with the practical gaps in rural technical conditions such as AI hardware facilities and digital educational resources. Fourthly, career planning is relatively weak, as teachers lack a clear understanding of their own professional development paths in the AI era.

5.3. Urban-Rural Disparity Comparison

5.3.1. District Y

In District Y, the core area of a first-tier city, key strengths in curriculum leadership factors include:

- High training frequency (B5 = 4.22, close to the overall sample average of 4.23), Training content focuses more on the cutting-edge applications of AI in preschool education and policy interpretation.
- High policy sensitivity (B10 = 4.12, ranked 2nd among all samples)

These reflect the city's rapid response to educational reforms and its leading capacity for curriculum innovation ($M = 3.13$). It responds rapidly to policies related to smart education, thereby providing a favorable policy environment for teachers to integrate AI tools and digital resources for curriculum optimization. Work satisfaction remains relatively high ($B7 = 4.11, SD = 0.797$, slightly below the overall sample mean of 4.17, $SD = 0.797$), indicating that some teachers recognize the current working environment for technology-empowered teaching; however, the standard deviation indicates a significant divergence in perceptions within this group regarding the adaptability of AI tools and the quality of technical training.

Persistent shortcomings include insufficient instructional support ($B4 = 4.03, SD = 0.788$), which is below the overall sample mean of 4.14. This deficiency can be attributed to the delayed upgrade of AI teaching

equipment, inadequate maintenance of digital resource libraries, and the insufficient allocation of preparation time for technology-integrated teaching in curriculum scheduling. Family and community support ($B9 = 4.11$, $SD = 0.784$) was below the overall sample mean of 4.16, indicating relative weakness. This suggests teachers perceive insufficient external support for the curriculum, explaining why the district's curriculum implementation capacity ($M = 2.92$) lagged behind other dimensions.

5.3.2. District Q

Among the factors influencing curriculum leadership in District Q of the prefecture-level city, key strengths include balanced teaching support ($B4 = 4.20$, $SD = 0.624$) and training frequency ($B5 = 4.21$, $SD = 0.658$) with low standard deviations. This indicates that kindergartens in this district have achieved balanced and comprehensive coverage across all campuses in terms of hardware support such as the provision of AI teaching equipment and the popularization of multimedia tools, as well as specialized training in the application of information technology and AI-assisted curriculum design, resulting in a high degree of consistency in teachers' perceptions of these initiatives. The highest job satisfaction score ($B7 = 4.21$, $SD = 0.658$) with the lowest standard deviation among the three districts reflects widespread recognition of the kindergarten environment. Strong family and community support ($B9 = 4.18$, $SD = 0.644$), exceeding the overall sample mean of 4.16, indicates stable mechanisms for family and community engagement in kindergarten curriculum. This equilibrium underpins the district's overall stable curriculum leadership ($M = 2.94$).

Existing shortcomings include insufficient career planning awareness ($B3 = 4.12$, $SD = 0.591$), which aligns with the overall sample but ranks lower, with a low standard deviation. This indicates teachers lack clarity regarding their professional development paths and exhibit high consensus on career uncertainty, necessitating systematic planning support. Policy awareness is slightly weaker ($B10 = 4.18$, $SD = 0.660$), marginally higher than the overall sample (4.16) but lower than Town C (4.22), with a low standard deviation. This reflects a prevalent deficiency in the dissemination and on-the-ground implementation of targeted special policies for the application of AI and information technology in preschool education, resulting in teachers having an indistinct perception of the relevant policy dividends.

5.3.3. Town S

As a town within the county, Town S exhibits the following primary strengths: the strongest family and community support ($B9 = 4.21$, $SD = 0.746$), with a moderate standard deviation indicating relatively stable support systems. Parents and communities demonstrate a high level of cooperation in teaching practices that integrate local resources with simple AI tools, which can provide stable support for teaching innovations including the digitalization of local curriculum and AI-based presentation of folk culture. However, notable contradictions exist: although training frequency stands out ($B5 = 4.28$, $SD = 0.769$), the high standard deviation implies that AI and information technology training suffers from the problem of “emphasizing form over substance”. Specifically, some training content is divorced from the actual context of rural teaching and lacks practical guidance, resulting in a disconnection between teachers' learning and practical application. In addition, both the mean and standard deviation of policy cognition ($B10 = 4.22$, $SD = 0.765$) rank the highest across the three regions, and perceptions of urban-rural resource disparities ($B8 = 4.00$, $SD = 0.892$) are the most prominent among them—these disparities primarily center on technological divides such as the shortage of AI hardware facilities, insufficient network bandwidth, and difficulties in accessing high-quality digital educational resources. Meanwhile, instructional management support ($B6 = 4.18$, $SD = 0.833$) is inadequate, due to a shortage of professional instructors for technology-integrated teaching and insufficient support for teachers in using AI tools to address teaching-related problems. These issues collectively result in the town's curriculum leadership performance ($M = 2.91$) ranking the lowest among the three regions, which exhibits the characteristic of “high input but low efficiency”, with detailed data presented in Table 11.

Table 11. Descriptive statistical results of each dimension of influencing factors.

Region	Item	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	Comparison
Y	Average value	4.04	3.97	3.99	4.03	4.22	4.09	4.11	3.93	4.11	4.12	
	Number of cases	157	157	157	157	157	157	157	157	157	156	B5 > B10 > B7 = B9 >
	Standard deviation	0.733	0.755	0.764	0.788	0.737	0.812	0.797	0.871	0.784	0.762	B6 > B1 > B4 > B3 >
	Total sum	634	623	627	633	662	642	645	617	646	642	B2 > B8
	Mean standard error	0.058	0.06	0.061	0.063	0.059	0.065	0.064	0.069	0.063	0.061	
Q	Average value	4.17	4.07	4.12	4.2	4.21	4.14	4.21	3.95	4.18	4.18	
	Number of cases	168	168	168	168	168	168	168	168	168	168	B5 = B7 > B4 > B9 =
	Standard deviation	0.606	0.759	0.591	0.624	0.673	0.686	0.658	0.78	0.644	0.66	B10 > B1 > B6 > B3 >
	Total sum	700	683	693	706	707	696	708	664	703	702	B2 > B8
	Mean standard error	0.047	0.059	0.046	0.048	0.052	0.053	0.051	0.06	0.05	0.051	
C	Average value	4.18	4.13	4.19	4.21	4.28	4.18	4.18	4	4.21	4.22	
	Number of cases	89	89	89	89	89	89	89	89	89	89	B5 > B10 > B4 = B9 >
	Standard deviation	0.791	0.842	0.721	0.776	0.769	0.833	0.791	0.892	0.746	0.765	B3 > B1 = B6 = B7 >
	Total sum	372	368	373	375	381	372	372	356	375	376	B2 > B8
	Mean standard error	0.084	0.089	0.076	0.082	0.081	0.088	0.084	0.095	0.079	0.081	
D	Average value	4.12	4.04	4.09	4.14	4.23	4.13	4.17	3.95	4.16	4.16	
	Number of cases	414	414	414	414	414	414	414	414	414	413	B5 > B7 > B9 = B10 >
	Standard deviation	0.699	0.777	0.692	0.726	0.718	0.767	0.742	0.838	0.721	0.722	B4 > B6 > B1 > B3 >
	Total sum	1706	1674	1693	1714	1750	1710	1725	1637	1724	1720	B2 > B8
	Mean standard error	0.034	0.038	0.034	0.036	0.035	0.038	0.036	0.041	0.035	0.036	
Comparison	C > B > D > A C > B > D > A C > B > D > A C > B > D > A C > D > A > B C > B > D > A B > C > D > A C > B = D > A C > B > D > A C > B > D > A											

Note: B1 indicates that I believe my educational philosophy is keeping up with the times; B2 means that I often have the opportunity to participate in professional training to enhance my teaching ability; B3 means that I have a clear plan for my career as a kindergarten teacher; B4 means that the kindergarten provides sufficient convenience and support for my teaching; B5 means that the kindergarten frequently organizes professional training or seminars; B6 means that I think the management style of the kindergarten is conducive to my teaching innovation; B7 means that I am very satisfied with my working environment; B8 means that I believe there are significant differences in educational resources between urban and rural areas; B9 means that family and community provide strong support for my educational work; B10 means that educational policies have a significant impact on my teaching work. Y represents District Y in Guangzhou; Q represents District Q in Qingyuan; C represents Town S in Liannan County; D represents the average value of the total sample.

5.4. Summary of Key Results

5.4.1. Overall curriculum leadership remains at a moderate level, featuring prominent dimensional imbalance and inadequate technology integration

The overall mean score for preschool teachers' curriculum leadership was 2.97, falling into the “moderate” level and thus leaving considerable room for improvement. Comparing the three regions, the mean scores were: Y District ($M = 3.05$) > Q District ($M = 2.94$) > C Town ($M = 2.91$). Y District demonstrated a significant advantage ($p < 0.05$) in the dimensions of “curriculum innovation capability” and “curriculum evaluation and reflection capability.” Among all dimensions, curriculum evaluation and reflection capability ($M = 2.87$) scored the lowest, representing a common weakness. Furthermore, the shortcomings are concentrated in the advanced application of AI—scores for items such as optimizing teaching strategies with AI data analysis tools are significantly lower than those for basic technology application.

5.4.2. Results of Regional Factors Related to Urban-Rural Disparities

Preschool teachers in District Y scored lower in teaching support ($B4 = 4.03$) and family-community support ($B9 = 3.93$), while scoring higher in policy sensitivity ($B10 = 4.12$) and training frequency ($B5 = 4.22$). With a high coverage rate of AI resources, teachers in District Y achieved higher scores in technology-driven curriculum innovation and data-driven evaluation.

In Q Zone, local resources ($B4 = 4.20$; $B5 = 4.21$), job satisfaction ($B7 = 4.21$) and family/community support ($B9 = 4.18$) are evenly balanced, while the score of career planning awareness ($B3 = 4.12$) is relatively low.

Town S has the highest scores in training frequency ($B5 = 4.28$) and policy awareness ($B10 = 4.22$) among the three regions, while its scores in perceived urban-rural resource disparities ($B8 = 4.00$) and management support ($B6 = 4.18$) are relatively low. This town is constrained by inadequate hardware facilities and inconsistent quality of AI-related training.

5.4.3. Demographic Variables Have a Notable Effect, with No Differential Effect Observed for Preschool Types

Small preschools (1–5 classes) demonstrated significantly higher curriculum design capability ($M = 3.21$) and overall curriculum leadership ($M = 3.10$) than large preschools ($p < 0.05$), reflecting the advantages of small-scale flexibility; teachers with 16 or more years of teaching experience showed the strongest curriculum implementation capability ($M = 3.01$) ($p < 0.01$); and teachers with a bachelor's degree or higher significantly outperformed other educational groups in evaluation and reflection capability ($p < 0.01$). There was no significant difference in curriculum leadership between public and private kindergartens ($p > 0.05$).

5.4.4. Standard Deviations Reflect Regional Educational Ecosystems, Aligning Cognitive Consistency with Developmental Matching

Q District exhibited the lowest standard deviations across all factors, while S Town recorded the highest standard deviations in urban-rural disparity perception ($SD = 0.892$) and educational philosophy renewal ($SD = 0.791$). A prominent disconnection between input and effectiveness exists in some regions: the training frequency (4.28 points) and policy cognition (4.22 points) of Town S both rank first among the three regions, yet its overall curriculum leadership falls to the bottom; while District Y boasts strong policy sensitivity, it lacks supporting measures such as the maintenance of AI teaching equipment and home-kindergarten technological collaboration.

6. Research Discussion

6.1. Recapitulation of Key Results

This study selected 414 kindergarten teachers from urban, suburban and rural areas of Guangdong Province as research subjects. The main findings reveal that the overall level of curriculum leadership among kindergarten teachers in urban and rural regions is moderate ($M = 2.97$). The dimensional performance ranks from high to low as follows: curriculum implementation and coordination ability (3.08) > curriculum concept innovation ability (3.03) > curriculum design and planning ability (2.98) > curriculum evaluation and reflection ability (2.87). Curriculum evaluation and reflection ability serves as a common shortcoming. Teachers' technology integration remains at a shallow application stage, failing to realize in-depth empowerment of the whole curriculum process. Such dimensional imbalance is not only a shared problem between urban and rural areas, but also a core bottleneck restricting the upgrading of curriculum quality, calling for the design of targeted mechanisms urgently.

Urban-rural differences were mainly reflected in three dimensions: Curriculum Ideological Innovation Ability, Curriculum Evaluation and Reflection Ability, and overall curriculum leadership ($p < 0.05$), with the digital divide as the core driving factor. Urban teachers had advantages in accessing cutting-edge AI resources and conducting data-driven evaluation, while rural teachers performed weakly due to limited hardware conditions. There were no significant urban-rural differences in Curriculum Design and Planning Ability and Curriculum Implementation and Coordination Ability ($p > 0.05$), which stemmed from the initial popularization of basic technologies in both urban and rural areas.

The influencing factors present regional heterogeneity and non-linear empowerment characteristics. District Y compensates for insufficient technical support through “policy + resources + training”, thereby gaining an advantage in curriculum leadership. Zone Q maintains steady development via “balanced resources + high job satisfaction”, yet inadequate career planning awareness restricts the long-term development of curriculum leadership. Town S is trapped in a dilemma of “high training input but low technological transformation” and lagging effectiveness due to “lack of management support and strong perception of resource gaps”. Such regional heterogeneity provides a practical foundation for constructing a “complementary and collaborative” development model.

Among demographic variables, teachers with 16 or more years of teaching experience demonstrate stronger curriculum implementation and coordination ability; teachers with a bachelor’s degree or above perform better in curriculum evaluation and reflection ability; and small-scale kindergartens with 1 to 5 classes present better performance in curriculum design and planning ability as well as overall curriculum leadership due to their flexibility advantages. Under policy guidance, the allocation of basic technical resources in private kindergartens has gradually become consistent with that in public kindergartens, and kindergarten ownership has no significant influence on curriculum leadership; the core restrictive factor of technological empowerment has shifted from “kindergarten ownership” to “resource quality and transformation efficiency”, which provides empirical support for weakening gaps caused by kindergarten ownership and focusing on precise empowerment in the follow-up.

Q District presents the lowest standard deviations across all factors, reflecting balanced regional resource allocation and high consensus among teachers; S Town shows the highest standard deviations in relevant indicators, indicating differentiation in technological adaptation within the teaching group. The disconnection between input and effectiveness in S Town results from insufficient management support and the lack of technological transformation mechanisms, while curriculum implementation efficiency in District Y is restricted by inadequate supporting measures, which further highlights the impact of regional educational ecological differences on the development of curriculum leadership.

From a critical perspective, this study finds that teachers in Town S have the highest training frequency and policy awareness among the three regions, but fail to effectively translate these advantages into practical improvement of curriculum leadership. This contradictory phenomenon deserves in-depth reflection. Whether there are deep-seated obstacles such as regional educational culture, kindergarten management systems, and rural teachers’ professional identity behind this has not been fully revealed in this study. Future research can further explore the institutional and cultural incentives for the inefficiency of technological empowerment, so as to provide more targeted theoretical basis and practical paths for solving the imbalance of technology application in urban and rural preschool education and improving the effectiveness of curriculum leadership development.

6.2. Comparison with Previous Studies

6.2.1. Alignment with the Distributed Leadership Theory

The distributed leadership theory proposed by Gronn (2002) emphasizes that leadership is dispersed within professional communities, which is consistent with the results of this study. Urban kindergartens, relying on sufficient resources, have formed a collective and collaborative curriculum leadership model. In contrast, rural kindergartens suffer from a shortage of teachers, forcing individual teachers to take on multiple roles, presenting a “lone warrior” model. This verifies the differentiated manifestation of the theory in urban and rural scenarios with different resource allocations.

6.2.2. Extension of Research on Urban-Rural Preschool Teachers’ Curriculum Leadership

Ma (2024) pointed out that rural teachers have weak curriculum awareness and urban teachers over-rely on standardized curricula. This study further deconstructed the dimensional differences under the background of digital empowerment, clarified the urban-rural performance differences in the four core dimensions, and revealed the new impact of the digital divide on curriculum leadership, enriching the contemporary connotation of research on urban-rural educational differences.

6.2.3. Supplement to Research on Urban-Rural Differences in Teaching and Research Resources

Luo (2024) focused on the gradient differences in urban-rural teaching and research resources. This study confirmed that teaching and research resources are not the only influencing factor; policy perception, training transformation efficiency, and kindergarten scale flexibility are all key moderating variables. This breaks through the “resource determinism” and provides a more comprehensive analytical framework.

6.2.4. Deepening of Research on Influencing Factors of Curriculum Leadership

This study first identifies the urban-rural gradient differences in educational resources, further clarifies the regional heterogeneity of the three-dimensional influencing factors (individual, organizational, and external environment), and reveals the “high input, low efficiency” dilemma of training transformation in rural areas, thus deepening research on the influencing mechanism of curriculum leadership.

6.2.5. Validation of the Dimensional Division of Curriculum Leadership

Zhu (2021) proposed the four-dimensional framework of curriculum leadership. This study verified the scientificity of this division through empirical data (Cronbach’s alpha coefficients all > 0.88, cumulative variance explanation rate 63.19%) and supplemented the differentiated performance of digital technology integration into each dimension, providing specific references for the practical application of the dimen.

6.3. Interpretation of the Mechanism of Urban-Rural Differences

The core driving mechanism of urban-rural differences is the digital divide, and regional development presents characteristics of non-linear empowerment:

Compensation effect of “policy-resource-training” in District Y: Despite insufficient teaching support and family-community support, District Y maintained a leading position in Curriculum Ideological Innovation Ability and Curriculum Evaluation and Reflection Ability through high policy sensitivity and high-frequency training focusing on cutting-edge AI applications.

Stabilizing effect of “balanced resources-high satisfaction” in District Q: Balanced coverage of resources such as AI equipment and technical training, coupled with high job satisfaction and a stable home-kindergarten-community collaboration mechanism, supported the stable development of overall curriculum leadership.

Restrictive effect of “high input-low transformation” in Town S: Although Town S ranked first in training frequency and policy perception, it suffered from hardware shortages such as insufficient smart devices and unstable networks. Additionally, training content was divorced from rural teaching practice, resulting in the lowest curriculum leadership ranking among the three regions.

The fundamental reason for regional heterogeneity lies in the differences in the allocation of resource supply, transformation efficiency, and environmental support. Urban areas have achieved effective technological empowerment, while rural areas have experienced interrupted empowerment due to insufficient hardware and the lack of transformation mechanisms.

6.4. Practical Implications for the Balanced Development of Urban-Rural Preschool Education

6.4.1. Constructing a Framework for Complementary and Collaborative Urban-Rural Development

Taking continuing education as a bridge, share the policy implementation experience of District Y, the resource allocation model of District Q, and the local resource development experience of Town S to build an “urban-rural resource interconnection network.” District Y should take the lead in sharing AI curriculum innovation experience; District Q should promote the balanced resource model; Town S should promote the digital curriculum transformation of local resources. Educational administrative departments need to strengthen investment in information technology infrastructure in rural kindergartens, encourage paired assistance between urban and rural kindergartens, and share digital resources and AI teaching tools.

6.4.2. Targeted Solutions to Common Weaknesses and Regional Challenges

Aim at the common weakness of weak Curriculum Evaluation and Reflection Ability by establishing a regular reflection mechanism, strengthening training on the application of AI data analysis tools. Formulate differentiated development paths according to kindergarten scale: small-scale kindergartens should strengthen their advantages in personalized curriculum design; large-scale kindergartens should build efficient management

frameworks. Design hierarchical training based on teaching experience and educational background to promote the balanced development of all types of teachers.

6.4.3. Building a Positive Feedback Loop System for “Input-Transformation-Effectiveness”

Establish a training quality evaluation system focusing on transformation effects rather than frequency to avoid resource waste. Improve policy implementation guarantees, refine resource allocation lists, and ensure that policy dividends reach grassroots kindergartens. Construct a “community-kindergarten-family” collaborative network, promote the in-depth integration of community resources with curricula, and effectively transform external support into motivation for improving curriculum leadership.

6.4.4. Deepening Scientific Research Support to Strengthen Practical Guidance

Promote the development of professional scales and construct standardized measurement tools suitable for preschool teachers’ curriculum leadership. Conduct longitudinal tracking studies to clarify the causal mechanism between influencing factors and curriculum leadership. Supplement qualitative research evidence, conduct in-depth exploration of the cultural and institutional causes of urban-rural differences, and enhance the practical guiding value of the research.

7. Conclusions

Through a questionnaire survey of preschool teachers in three urban-rural gradient regions in Guangdong Province, this study explored the differences and influencing mechanisms of urban and rural preschool teachers’ curriculum leadership under the background of digital empowerment. The core conclusions are as follows:

The overall curriculum leadership of urban and rural preschool teachers is at a moderate level with unbalanced dimensional development, and Curriculum Evaluation and Reflection Ability is a common weakness. The digital divide is the core of urban-rural differences, mainly reflected in Curriculum Ideological Innovation Ability, Curriculum Evaluation and Reflection Ability, and overall curriculum leadership. Regional development presents characteristics of non-linear empowerment: District Y leads through the compensation effect of “policy-resource-training”; District Q achieves stable development relying on “balanced resources-high satisfaction”; Town S lags behind due to the restrictive effect of “high input-low transformation.” Teaching experience, educational background, and kindergarten scale have significant impacts on curriculum leadership, while the nature of kindergartens has no significant impact.

This study reveals the new form of urban-rural preschool education differences in the digital era and provides practical directions for promoting the balanced development of urban-rural preschool education. It is necessary to focus on bridging the digital divide, construct an urban-rural collaborative mechanism, implement precise empowerment strategies, and improve the full-chain system of “resource supply-transformation efficiency-environmental support” to achieve the connotative balance of urban-rural preschool education.

8. Research Contributions

8.1. Theoretical Contributions

The study verified the four-dimensional framework of preschool teachers’ curriculum leadership (Curriculum Ideological Innovation, Design and Planning, Implementation and Coordination, Evaluation and Reflection) under the background of digital empowerment, supplemented the differentiated performance of technology integration into each dimension, and enriched the dimensional research system of curriculum leadership.

It enriched the empirical research on the distributed leadership theory in urban-rural preschool education scenarios, revealed the differentiated manifestation of the theory in different resource allocation environments, and provided support for the localized application of the theory.

It deepened the research on the urban-rural educational digital divide, broke through the single perspective of “hardware gap”, supplemented the research framework of “hardware gap-software transformation-effectiveness output”, and revealed the intermediate mechanism of the digital divide affecting curriculum leadership.

8.2. Practical Contributions

It provided a targeted basis for improving the curriculum leadership of urban and rural preschool teachers, clarified the empowerment priorities for teachers in different regions and with different characteristics (such as teaching experience and educational background), and avoided a one-size-fits-all improvement model.

It provided a full-chain solution of “training transformation-resource matching-management support” for the digital empowerment of rural preschool education, targeting the core dilemma of “high input but low efficiency” in rural areas.

It provided empirical support for educational administrative departments to formulate policies for the balanced development of urban-rural preschool education, clarified the core directions of policy formulation (such as rural hardware supplement, training quality optimization, and urban-rural collaboration), and improved policy scientificity.

9. Research Limitations

Limited regional representativeness of samples: The samples only cover three urban-rural gradient regions in Guangdong Province, which are greatly affected by regional culture and economic development level.

Relative singleness of research methods: The study mainly adopts the questionnaire survey method, lacking the supplement of qualitative research such as interviews and classroom observations, making it difficult to deeply explore the subjective motivations and practical contexts behind teachers’ behaviors, and the interpretation of results is not comprehensive enough.

Cross-sectional research design: Only data at a specific time point are collected, which cannot track the dynamic development of curriculum leadership, and it is difficult to clarify the causal relationship between influencing factors and curriculum leadership, with the risk of reverse causality misjudgment.

10. Future Research Directions

Expand the sample scope: Extend the samples to provinces with different economic development levels across the country, covering eastern, central, and western regions, to improve the regional representativeness and universality of the research conclusions.

Adopt mixed research methods: Combine questionnaire surveys with qualitative research to conduct in-depth exploration of the cultural and institutional causes of urban-rural differences, and provide more abundant contextual explanations for quantitative results.

Conduct longitudinal tracking studies: Track the same group of teachers for a long time, continuously collect data on curriculum leadership and influencing factors, explore their dynamic development laws, and clarify the causal mechanism between influencing factors and curriculum leadership.

Author Contributions

C.L.: conceptualization, methodology, investigation, data curation, formal analysis, validation, writing—original draft preparation, writing—reviewing and editing; Y.L.: conceptualization, methodology, validation, investigation, funding acquisition, supervision, writing—reviewing and editing; Y.W.: data curation, formal analysis, validation, visualization, resources, writing—reviewing and editing; C.F.: project administration, writing—reviewing and editing; S.H.: supervision, project administration, writing—reviewing and editing; F.G.: resources, validation. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Ethical review and approval were waived for this study, due to the reason that the study adopted an anonymous questionnaire survey method, all participants participated voluntarily, the research content did not involve sensitive personal information, and no physical or psychological harm would be caused to the participants.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The raw data of this study cannot be made publicly available due to the need to protect the privacy and confidentiality of the research participants. Aggregated data supporting the conclusions of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest. The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Use of AI and AI-Assisted Technologies

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