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# Curriculum-based professional learning in early childhood education: Conceptualization, implementation and evaluation

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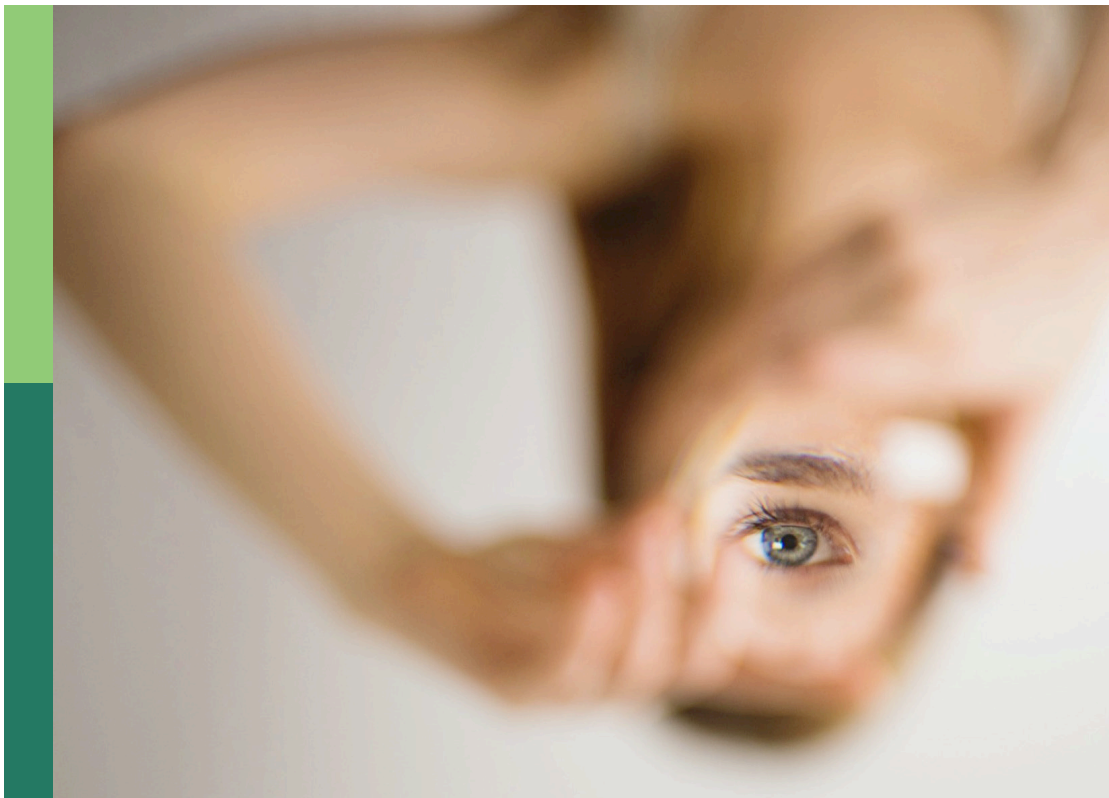
**Published in**
Frontiers in Psychology
Frontiers in Education



ISSN 1664-8714
ISBN 978-2-8325-3196-9
DOI 10.3389/978-2-8325-3196-9

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# Curriculum-based professional learning in early childhood education: Conceptualization, implementation and evaluation

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**Citation**

Yang, W., Bautista, A., Li, H., Wang, C., eds. (2023). *Curriculum-based professional learning in early childhood education: Conceptualization, implementation and evaluation*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-3196-9

# Table of contents

frontiers | Frontiers in Psychology

TYPE Editorial
PUBLISHED 25 July 2023
DOI 10.3389/fpsyg.2023.1252236



OPEN ACCESS

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RECEIVED 03 July 2023
ACCEPTED 11 July 2023
PUBLISHED 25 July 2023

CITATION
Yang W, Bautista A and Li H (2023) Editorial: Curriculum-based professional learning in early childhood education: conceptualization, implementation and evaluation.
*Front. Psychol.* 14:1252236.
doi: 10.3389/fpsyg.2023.1252236



# Editorial: Curriculum-based professional learning in early childhood education: conceptualization, implementation and evaluation

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KEYWORDS

**curriculum-based professional learning, early childhood education, teacher professional development, conceptualization, implementation, evaluation**

Editorial on the Research Topic
Curriculum-based professional learning in early childhood education: conceptualization, implementation and evaluation

## Introduction

The quality of early childhood education (ECE) has a significant impact on children's development and learning outcomes; thus, it is essential to provide effective professional learning opportunities for ECE educators to enhance their knowledge and skills. One promising approach is curriculum-based professional learning (CBPL, Short and Hirsh, 2020), which integrates high-quality curriculum approaches and materials into professional learning activities. This allows teachers to experience the same learning programs as their children and improve their pedagogical practices accordingly. However, there is a lack of empirical evidence on how to implement and evaluate CBPL in ECE settings. To fill this gap, this Research Topic collects a set of empirical explorations of the practices of CBPL in varying contexts and cultures. This editorial synthesizes the findings from this Research Topic, which has addressed the conceptualization, implementation, and evaluation of CBPL in ECE from different perspectives. In particular, this Research Topic comprises three articles that examine the theoretical foundations, frameworks, and components of CBPL; two articles that describe the design and implementation of CBPL initiatives for ECE teachers; and four articles that evaluate the effects of CBPL on teachers and their children. Next, we present brief summaries of each of the studies in the Research Topic according to these categories.

## Theoretical underpinnings of CBPL: framework and components

Some of the studies included in this Research Topic contribute to understanding the key components and processes involved in developing and implementing CBPL initiatives that support ECE principals and teachers in effectively engaging with the curriculum.

First of all, practitioner inquiry and teachers' CBPL are closely related concepts that are both focused on improving teaching practice and student learning outcomes (Campbell and McNamara, 2009). In their paper, Yan and Zhao investigated the relationship between kindergarten school-based practitioner inquiry and preschool teachers' teaching ability, finding that school-based practitioner inquiry positively predicts teaching beliefs and teaching ability. The study highlights the mediating role of constructivist beliefs in teaching, emphasizing the importance of examining the role of teachers' beliefs and teacher inquiry in the development of effective CBPL initiatives.

Tian et al. explored CBPL in China's ECE contexts, with a focus on teachers becoming curriculum designers. This study was drawn upon the Curriculum Design Coherence Model, which is a theoretical framework designed to assist teachers in designing courses that integrate subject concepts, content, and competencies in a coherent way (Rata, 2019; McPhail, 2021). The model's intended usefulness as a curriculum design tool is to contribute to teachers' pedagogical decision-making and professional learning (Rata and McPhail, 2020). By integrating subject concepts, content, and competencies in a coherent way, the model aims to create a curriculum that promotes deep learning and is effective, engaging, and meaningful for learners (McPhail, 2021).

Qian et al.'s study further explored the professional development needs of kindergarten principals in China and found that 70.3% of them had a high need for professional development. The study identifies three profiles of professional development needs and reveals significant rural-urban and public-private differences in the professional backgrounds and professional development needs of the Chinese ECE principals. The findings suggest a noticeable "Matthew effect" in which the poor receive less professional development than the rich. The study's implications for future leader development policy and program development relate to the importance of meeting the professional development needs of kindergarten principals to improve kindergarten quality. This study highlights the need for professional development among educational leaders, who can play a crucial role in supporting and promoting teachers' professional learning within the curriculum.

## Creating and implementing effective CBPL initiatives for ECE teachers

Two other studies focus on developing and evaluating CBPL initiatives for ECE teachers. Saxena and Chiu reported on a CBPL program designed to develop preschool teachers' computational thinking knowledge, attitudes, beliefs, and teaching self-efficacy. They implemented a 6-month training program designed to help teachers develop their understanding and implementation of computational thinking in ECE. The program includes six workshops, a summer training institute, and hands-on practice with related activities including both plugged and unplugged computational thinking. The workshops cover the critical dimensions of computational thinking, pedagogical understanding of computational concepts, practices, and perspectives, and the development of teacher beliefs to support their teaching. Teachers collaborate to design shared curricula and lessons for ECE and develop further learning and teaching resources to institutionalize the integration of computational thinking. Their study highlights the potential of CBPL initiatives to empower ECE teachers to integrate new and innovative approaches into their teaching practice.

In another study, Peng et al. presented the adaptation and validation of a scale for measuring the CBPL community in ECE in China. The Curriculum-Based Professional Learning Community (CBPLC) scale is shown to be a validated tool developed to measure the professional learning community of preschool teachers in the Chinese context. It consists of four factors, including Shared Sense of Purpose, Collective Focus on Children Learning and Development, Collaborative and Reflective Activity, and Deprivatized Practice (Peng et al.). The scale has high reliability and validity, and was found to have a significant positive correlation with teachers' teaching efficacy (Peng et al.). This research contributes to the development of tools and strategies for evaluating and improving the effectiveness of CBPL initiatives in ECE settings.

## Assessing the impact of CBPL on ECE teachers' beliefs and practices and young children's learning and development

The remaining studies explore the impact of CBPL initiatives on ECE teachers and young children's learning and development. First, Yu and Li investigated the transferable skills of children based on STEAM education (practical drawing in this study), providing insights into the potential impact of CBPL initiatives on young children's learning and development. Their research underscores the importance of aligning CBPL initiatives with evidence-based approaches that support children's holistic development.

Zhang et al. explored the relationship between Chinese preschool principal leadership styles and teacher leadership, examining the mediating effect of psychological capital. Their findings highlight the role of leadership in influencing the success of CBPL initiatives and the importance of fostering a supportive and empowering environment for ECE teachers.

Yang and Hong conducted a qualitative exploratory study on early childhood teachers' professional learning about the integration of information and communication technologies in kindergarten curriculum in China. The article discusses the importance of professional learning opportunities for ECE teachers to support their use of digital technologies in the classroom. The study found that ECE teachers in China had received diverse types of professional learning opportunities related to technology use, but there is a need for a teaching-research culture to support their professional learning and to advance current programs. Their research contributes to an understanding of the challenges and opportunities associated with integrating technology into ECE settings and the role of CBPL in supporting this process.

Finally, Xie et al. presented a Chinese model of classroom walkthroughs as an effective strategy for preschool improvement during the COVID-19 lockdowns. Their study emphasizes the potential of CBPL initiatives to support ongoing professional learning and adapt to changing circumstances in the ECE context.

## Conclusion

This Research Topic presents a variety of studies that advance our knowledge of the conceptualization, implementation, and evaluation of CBPL in ECE. Specifically, the papers in this Research Topic emphasize the significance of examining the theoretical foundations of CBPL, designing and implementing effective CBPL initiatives, and measuring their effects on teachers' beliefs and practices as well as children's learning and development. These studies and their findings underscored the potential of CBPL to transform ECE teachers' professional learning experiences and ultimately improve the quality of early learning environments for young children. By building a community of researchers interested in ECE curriculum, pedagogy, and teacher professional development, we can continue to advance our understanding of the opportunities and challenges associated with CBPL and work toward a more effective and equitable ECE system globally.

## Author contributions

WY: conceptualization, writing—original draft preparation, writing—reviewing and editing, and supervision. AB and HL: writing—reviewing and editing. All authors contributed to the article and approved the submitted version.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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frontiers in Psychology

ORIGINAL RESEARCH
published: 15 March 2022
doi: 10.3389/fpsyg.2022.814521

# The Relationship Between School-Based Research and Preschool Teachers' Teaching Ability: The Mediating Role of Constructivist Beliefs in Teaching

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To understand the relationship between kindergarten school-based research (SBR) and preschool teachers' teaching ability and identify the mechanism by which SBR affects teachers' teaching ability, a survey of randomly sampled preschool teachers in Sichuan Province ($N$ = 625, $M_{age}$ = 26.61) was conducted online using three scales assessing community learning, teaching ability and teaching philosophy. The survey results showed that the level of SBR reached the upper-middle level. The level of SBR positively predicted the teaching beliefs and teaching ability of preschool teachers. SBR influenced teaching ability through direct and indirect effects, with indirect effects accounting for 23.5% of the total effect; however, only constructivist teaching beliefs played a mediating role in the relationship between SBR and teaching ability *via* an indirect effect. SBR focused on improvement in teaching ability should not only examine the connection between SBR and practical problems to promote improvement in teachers' teaching ability but also should examine the role of teachers' beliefs and influence teachers' teaching abilities by changing teachers' teaching beliefs.

**Keywords: school-based research, teaching ability, teaching belief, the mediating role, preschool teacher professional development**

OPEN ACCESS

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***Specialty section:***
*This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology*

***Received:*** *13 November 2021*
***Accepted:*** *31 January 2022*
***Published:*** *15 March 2022*

***Citation:***
*Yan Z and Zhao S (2022) The Relationship Between School-Based Research and Preschool Teachers' Teaching Ability: The Mediating Role of Constructivist Beliefs in Teaching. Front. Psychol. 13:814521. doi: 10.3389/fpsyg.2022.814521*

## INTRODUCTION

High-quality education is the pursuit of contemporary education (Early et al., 2007; Tikly and Barrett, 2011). Teacher competence is considered a key factor affecting the quality of education (Fauth et al., 2019; Manning et al., 2019). The professional development of teachers has been regarded as a key way to ensure the quality of education (Tatto, 2015). According to *professional learning community* theory, teachers' professional development should be closely related to the classroom teaching situation, and it should implemented through teachers' individual reflection and peer coaching in professional learning community (Imants et al., 2001; Shulman and Sherin, 2004; Singer and Moscovic, 2008). SBR directly affects the improvement of teachers' teaching ability due to the emphasis on practical problems (Gao and Wang, 2014), and it is regarded by researchers as an effective approach to teachers' professional development (van Velzen and Volman, 2009; Fang, 2017). In addition, SBR changes teachers' teaching beliefs by continuously promoting teachers' reflection (de Vries et al., 2013; Chaaban, 2017) and, in turn, leads to improvement in teachers' teaching abilities. There are two ways to influence teachers' teaching abilities: direct influence and

indirect influence. *Via* indirect effects, teachers' teaching beliefs play a mediating role. Therefore, studying the relationships among SBR, teaching beliefs and teaching abilities is conducive to further confirming the value of SBR.

## School-Based Research as a Learning Community

School-based research in kindergarten in China is also related to the conduct of school-based curricula. The wave of school-based curriculum reform in China in 2001 promoted the exploration of theory and practice of the curriculum for children in kindergarten (Chen and Yan, 2001; Li, 2006). Because of limitations of preschool teachers' quality, curriculum development cannot be carried out in many kindergartens, and SBR in kindergarten has been proposed by some Chinese researchers on ECE (Zhang and Zhu, 2005; Zhu and Wang, 2005).

School-based research in kindergarten involves preschool teachers, teaching and research managers, teaching and research experts and other relevant parties in the teaching and research community. Actively paying attention to the kindergarten care and teaching process and solving the actual problems of early childhood education (ECE) and care can improve the quality of care and ECE and promote the professional development of teachers. Research and practice are parallel activities for the ultimate goal of child development (Huang, 2019). It has been proposed that the nature of SBR is action research, which originated from the "Teacher Action Research Movement" in the 1950s. Commonality is reflected in multi-agent participation, that is, the use of science by teachers, administrators and other relevant personnel. Some methods of research aim to improve practice (Martyn, 1993). Since SBR in kindergarten is often focused on a certain problem (such as the curriculum), SBR usually involves workshops. Therefore, SBR is essentially a "learning community" organized for kindergartens (Huang, 2017).

School-based research is regarded as a professional learning community (PLC) (Shulman and Sherin, 2004; Huang, 2017). A PLC is a school organization structure with an intellectually directed culture typified by "reflection, dialog, sharing, and practice." According to their common interests or goals, the members share, inspire, explore and apply to achieve common vision and development goals through collective learning (Louis and Marks, 1998; Molla and Nolan, 2019).

## School-Based Research Is Conducive to Improving Teachers' Teaching Ability

Due to the situational nature of teaching activities, although teachers already possess relevant theoretical knowledge of education and teaching, the application of this knowledge in practice must be combined with specific scenarios, and SBR is the most suitable way to encourage teachers to improve their teaching ability (Imants et al., 2001; Chen and Zhang, 2014).

However, other studies suggest that the relationship between SBR (i.e., teacher professional development workshops) and changes in teachers' teaching behavior ability is still uncertain (Schachter, 2015). Because SBR in kindergarten focuses on practical problems in kindergartens and pays attention to the educational situation of children and kindergartens (Li, 2011), and SBR in kindergarten should promote improvement in preschool teachers' teaching ability. Therefore, this research proposes hypothesis H1 as follows: SBR can positively predict preschool teachers' teaching ability.

## School-Based Research Is Conducive to Changing Teachers' Teaching Beliefs

Teaching ability is a professional ability that promotes the achievement of teaching goals based on professional and pedagogical knowledge in a specific educational and teaching situation. It represents the teaching and organizational ability of a teacher in teaching and education activities (Dios et al., 2018). The potential for teaching to be improved by SBR is mainly reflected in the fact that teachers can acquire practical knowledge, promote the contextualization of existing knowledge, and acquire specific behaviors and ways of doing things (Chen and Zhang, 2014).

Teachers' beliefs involve their views concerning the curriculum and the relationship between teachers and students (Peterson et al., 1989). Teachers' teaching beliefs include two aspects, namely, traditional teaching beliefs and constructivist teaching beliefs (CTBs). Traditional teaching beliefs refer to teacher-centered beliefs; teachers with such beliefs often pay more attention to the results of learning rather than the process. In contrast, CTBs are reflected in student-centered beliefs and are focused on cultivating students' critical thinking, reflective ability, and cooperative ability (Teo and Zhou, 2017; Papadakis and Kalogiannakis, 2020; Papadakis, 2021).

Chan and Elliott (2004) compiled the Teaching Belief Scale (TLCQ), which is divided into two dimensions, namely, traditional teaching beliefs and CTBs. The scale has 30 items in total. A simplified version of the Conceptions of Teaching and Learning (COTL) scale was developed by Teo and Zhou (2017). The scale also includes two dimensions: traditional teaching concepts (TTCs) and constructivist teaching concepts (CTCs). For this research, the simplified Teachers' Teaching Beliefs Scale compiled by Teo and Zhou was adopted.

Changing teachers' beliefs requires the presentation of the problem situation and the teacher's own reflection (Yang, 2010) and SBR, which emphasizes practical problems and essentially presents the real problem situation; thus, the reflective environment of the teacher community naturally drives teachers' individual reflection. SBR can therefore change the beliefs of teachers.

Generally, participating in teaching and research activities (especially centralized education and training) can help teachers adopt advanced educational concepts (Pang and Ye, 2000). The cultivation of teacher education concepts needs to be based on the teacher's experience and the school education situation (Liang and Xin, 2015), which are characteristics of SBR. The research of de Vries et al. (2013) showed that teachers' participation in professional development activities (participation in seminars, training and other activities to update knowledge and skills) has an important impact on their teaching beliefs. For teaching

activities among teachers with the same background, reflection and criticism among teachers is also conducive to changes in teachers' educational concepts. Chaaban (2017) confirmed through research that SBR can change teachers' educational concepts. This view is similar to related peer learning (Cui and Wang, 2016) and apprenticeship training (Rinke et al., 2014; Billett, 2016).

Some researchers have also found that professional learning communities are conducive to the development of preschool teachers' teaching beliefs (Keung et al., 2020); that is, school-based training or SBR that values practical experience is conducive to improving teachers' beliefs (Hursen and Islek, 2017). However, some scholars argue that the relationship between the two is not clear (Lander et al., 2017). Therefore, this research attempts to verify the relationship between SBR and teachers' educational beliefs and proposes Hypothesis H2 as follows: SBR has a positive predictive effect on teachers' teaching beliefs.

## The Relationship Between Teachers' Teaching Beliefs and Teaching Ability

Teachers' teaching behavior is influenced by their beliefs (Yu, 2007; Mertala, 2019; Papadakis and Kalogiannakis, 2020); teachers' teaching beliefs are the internal foundation of all teachers' thoughts, words and deeds in the classroom, including the presentation of the subject content, the presentation method, and students' difficulty in mastering the learning content.

Xin et al. (1997) studied the relationship between the educational beliefs of primary school teachers and their teaching monitoring ability and found a significant correlation between them; that is, teachers' educational beliefs directly affected their teaching monitoring ability. Once a teacher's teaching monitoring ability was improved, the teacher consciously change inappropriate teaching behaviors.

Preschool teachers' beliefs have been found to have a greater impact on their ability (Mohamed and Al-Qaryouti, 2016; Kim, 2017). Teachers with stronger beliefs show more positive practical intentions (Yin et al., 2021). Since educational beliefs and educational abilities may have a consistent theory and foundation, only combining the two in practice can truly promote improvement in teachers' quality (Pang and Ye, 2000).

Huang and Zhang (2019) found a weak correlation between preschool teachers' beliefs in preschool mathematics education and their teaching behaviors through a survey of 120 preschool teachers. However, a survey of 274 preschool teachers by Sim and Miai (2021) showed a significant positive correlation between the teaching ability and teaching beliefs of preschool teachers. Different numbers of survey respondents usually produce different conclusions. This study attempts to expand the sample size and further examine the relationship between preschool teachers' teaching beliefs and teaching abilities. In particular, it emphasizes the predictive effect of teaching beliefs on teaching ability. Therefore, hypothesis H3 is proposed as follows: the teaching beliefs of preschool teachers have a positive predictive effect on their teaching abilities.

If the previous three hypotheses are correct, preschool teachers' teaching beliefs may play an intermediary role between SBR and preschool teachers' teaching ability. Therefore, hypothesis H4 is proposed: preschool teachers' teaching beliefs play an intermediary role between SBR and teaching ability.

## Value of the Research

In the high school stage, teachers' participation in SBR activities is conducive to improving teachers' teaching ability (Wei et al., 2021). Does the same relationship exist the ECE stage? Some researchers believe that participating in SBR can change teachers' teaching beliefs and promote teachers' teaching ability. In other words, teachers' educational beliefs have an intermediary effect between SBR and teachers' educational ability. Currently, there is no relevant quantitative research to support this statement. The existing research has been from the perspective of teacher participation (Ke et al., 2019), but quantitative research on teacher participation in SBR is relatively lacking.

The importance of the diversity of kindergarten classes for the implementation of the ECE curriculum has been emphasized. However, in China, there are not only age differences in kindergarten students but also differences between kindergartens (Chen and Yan, 2001; Li, 2006). Therefore, the curriculum should be developed based on the diversity and specialty of each kindergarten. In the opinion of researchers, SBR can improve teachers' teaching ability (Chen and Zhang, 2014; Dios et al., 2018), but there is a lack of quantitative research on this issue. Thus, the study attempts to use quantitative research to illustrate the relationship among SBR, teaching beliefs, and teaching ability.

In addition, since SBR is essentially a type of cultural learning, studying the relationship between SBR and teachers' teaching concepts and teaching ability is conducive to further confirming the value of SBR based on quantitative research and is beneficial for further exploring the mechanism by which SBR affects teaching ability.

# MATERIALS AND METHODS

## Participants

The participants were $N$ = 625 preschool teachers (female, $M_{age}$ = 26.61) recruited online in Sichuan, People's Republic of China, using Questionnaire Star. A total of 653 questionnaires were collected, and 625 valid questionnaires were obtained, with an effective rate of 95.7%.

A total of 2.2% of preschool teachers had an advanced teacher job title, 8% had a first-level teacher job title, 14.7% had a secondary-level teacher job title, 5.8% had a third-level teacher job title, and 69.3% had an unrated job title. A total of 1.8% of preschool teachers had earned a postgraduate degree, 93.6% had earned a bachelor's degree or had completed junior college, and 4.6% had completed high school.

## Procedure

The survey procedures in the study were reviewed and approved by the Ethics Review Board of Northeast Normal University.

The survey was completed online by 653 preschool teachers in Sichuan Province in China who voluntarily participated in the questionnaire. The questionnaire survey was divided into two processes: a pilot survey and a formal survey. There were 100 preschool teachers participating in the pilot survey. The data from the pilot survey showed that the reliability and validity of the questionnaire were good and that a formal questionnaire survey could be conducted.

## Instruments

### School-Based Research Level

The Dimensions of the Learning Organization Scale (DLOQ Scale) (Watkins and Marsick, 2003) was accepted in the PLC (Louis and Marks, 1998; Dou and Zhang, 2006). This study adopted the PLC scale compiled by Louis and Marks (1998) and revised by Yin et al. (2019). As such, preschool teachers completed the *sense of purpose* (SP) subscale, which comprises 3 items (e.g., "Most of my colleagues agree with me on what the developmental goals of kindergarten should be," $\alpha = 0.89$); the *collective focus on student learning* (CFSL) subscale, which comprises 4 items (e.g., "My colleagues and I will provide children with a variety of suitable activities," $\alpha = 0.96$); the *reflective dialog* (RD) subscale, which comprises 4 items (e.g., "During brainstorming sessions, we discuss the methods and strategies for assessing young children's behavior," $\alpha = 0.97$); the *deprivatized practice* (DPR) subscale, which comprises 3 items (e.g., "My colleagues often observe the performance of the children in our class," $\alpha = 0.93$); and the *cooperative activity* (CA) subscale, which comprises 5 items (e.g., "I often conduct teaching and research activities with my colleagues," $\alpha = 0.94$) rated on a 5-point scale (from 1 = "strongly disagree" to 5 = "strongly agree"). The PLC has been shown to be reliable and valid in Chinese teachers (Yin et al., 2019).

### Preschool Teachers' Teaching Belief

This study adopted the Conceptions Of Teaching and Learning (COTL) scale developed by Teo and Zhou (2017). As such, preschool teachers completed the *traditional teaching beliefs* subscale, which comprises 5 items (e.g., "The effect of teacher's direct teaching is better than that of children's self-exploration," $\alpha = 0.97$), and the *constructivist teaching beliefs* subscale, which comprises 5 items (e.g., "Young children should be given many opportunities to express their ideas," $\alpha = 0.91$) rated on a 7-point scale (from 0 = "strongly disagree" to 6 "strongly agree"). The COTL has been shown to be reliable and valid (Teo and Zhou, 2017).

### Preschool Teachers' Teaching Ability

In this study, we used *the Scale of Organizational and Didactic Competencies for Educators* (ESCOD) compiled by Dios et al. (2018). As such, preschool teachers completed the *teaching* subscale, which comprises 14 items (e.g., "Adjust the activity plan according to the education and teaching situation," $\alpha = 0.93$), and the *organization* subscale, which comprises 9 items (e.g., "Collaborate with kindergarten colleagues and leaders," $\alpha = 0.89$) rated on a 7-point scale (from 0 = "no development" to 6 "very well developed"). The ESCOD has been shown to be reliable and valid (Dios et al., 2018).

## Analytical Strategy

In this study, SPSS 25.0 was used to conduct *t test*s, correlation analyses and regression analyses of the three variables. Then, we used AMOS 23.0 to analyze the fit indices of the scales and the mediating role of preschool teachers' teaching beliefs in the relationship between SBR and teachers' teaching ability. The fit indices of the scales ($X^2$/df, IFI, CFI, NFI, RFI, TLI, RMSEA, **Table 4**) in the study were within the acceptable range (Hu and Bentler, 1999), indicating that the model had good fit and good structural validity.

# RESULTS

## Preliminary Analyses

Descriptive statistics and correlations for all study variables are displayed in **Tables 1**, **2**. The results from F/*t* tests indicate no differences in teaching beliefs by job title ($M_{\text{advanced-level}} = 4.60$, $SD = 1.05$; $M_{\text{first-level}} = 4.67$, $SD = 1.24$; $M_{\text{secondary-level}} = 4.57$, $SD = 1.19$; $M_{\text{third -level}} = 4.47$, $SD = 1.54$; $M_{\text{unrated}} = 4.49$, $SD = 1.31$; $F = 0.31$, $p > 0.05$). There is a significant difference in SBR by teachers' job titles ($M_{\text{advanced-level}} = 4.38$, $SD = 0.63$; $M_{\text{first-level}} = 4.28$, $SD = 0.66$; $M_{\text{secondary-level}} = 3.98$, $SD = 0.74$; $M_{\text{third -level}} = 4.13$, $SD = 0.85$; $M_{\text{unrated}} = 3.98$, $SD = 0.83$, $F = 2.48$, $p < 0.05$) and kindergarten rank ($M_{\text{Demonstration-k}} = 4.14$, $SD = 0.83$; $M_{\text{first-level-k}} = 4.13$, $SD = 0.85$; $M_{\text{secondary-level-k}} = 4.11$, $SD = 0.74$; $M_{\text{third -level-k}} = 3.84$, $SD = 0.69$; $M_{\text{unrated}} = 3.86$, $SD = 0.81$, $p = 0.31$, $F = 4.02$, $p < 0.01$), and a difference in teaching ability between by teachers' job titles ($M_{\text{advanced-level}} = 6.03$, $SD = 0.84$; $M_{\text{first-level}} = 6.15$, $SD = 1.03$; $M_{\text{secondary-level}} = 5.57$, $SD = 0.96$; $M_{\text{third -level}} = 5.73$, $SD = 1.17$; $M_{\text{unrated}} = 5.53$, $SD = 1.19$, $F = 3.91$, $p < 0.01$).

Furthermore, there is a significant difference in teaching ability by kindergarten rank ($p < 0.05$) and no differences in teaching ability by teachers' educational backgrounds ($p > 0.05$) (**Table 1**).

**Table 2** shows that the overall level of SBR in the kindergartens where the survey respondents were located is at the upper-middle level ($M_{\text{SBR}} = 4.02 > 3$, $SD = 0.81$), and the overall level of preschool teachers' teaching ability is at the upper-middle level ($M_{\text{TA}} = 5.61 > 3$, $SD = 1.15$).

## Correlation Analyses

Based on the linear correlation analysis of SBR in kindergarten and preschool teachers' teaching ability (**Table 2**), the overall level of SBR and its dimensions are significantly positively correlated with preschool teachers' teaching ability and its dimensions ($p < 0.01$). The overall level of SBR has a moderately positive correlation with preschool teachers' teaching ability and its various dimensions. The correlation coefficient with total teaching ability is 0.64.

The linear correlation analysis between the level of SBR and teaching beliefs (**Table 2**) shows that SBR and all its

dimensions have a significant positive correlation with preschool teachers' teaching beliefs and its dimensions ($p < 0.01$). The correlation coefficient between the overall level of SBR and teaching beliefs is 0.39.

The linear correlation analysis of teaching beliefs and teaching ability (**Table 2**) shows no correlation between traditional teaching beliefs and teachers' organizational ability and a significant positive correlation between other factors ($p < 0.01$). The correlation coefficient between preschool teachers' teaching beliefs and teaching ability is 0.33.

## Regression Analysis

Under the premise that SBR is significantly positively correlated with preschool teachers' teaching ability, we further test the interpretation and prediction of the effect of the level of SBR on preschool teachers' teaching ability. In this study, the SBR level and its various dimensions (i.e., sharing goals, cooperative

**TABLE 1 |** The difference test of SBR and teaching ability.

| Variable | | | *N* | Mean | SD | F/*t* value | Comparison afterward |
|---|---|---|---|---|---|---|---|
| TA | K-R | D- kindergarten | 155 | 5.80 | 1.15 | 3.25* | 4 < 1*; 5 < 1*, 3* |
| | | F- kindergarten | 78 | 5.68 | 1.27 | | |
| | | S- kindergarten | 157 | 5.68 | 0.98 | | |
| | | T-kindergarten | 27 | 5.27 | 1.21 | | |
| | | U- kindergarten | 208 | 5.42 | 1.20 | | |
| TA | E-B | Master's degree | 11 | 4.80 | 1.53 | 2.16 | |
| | | University | 585 | 5.62 | 1.20 | | |
| | | High school | 29 | 5.74 | 1.10 | | |
| TA | J-T | A- teacher | 14 | 6.03 | 0.84 | 3.91** | 3 < 2*; 5 < 2* |
| | | F-teacher | 50 | 6.15 | 1.03 | | |
| | | S- teacher | 92 | 5.57 | 0.96 | | |
| | | T- teacher | 36 | 5.73 | 1.17 | | |
| | | U- teachers | 433 | 5.53 | 1.19 | | |
| TB | K-R | D- kindergarten | 155 | 4.70 | 1.34 | 1.61 | |
| | | F- kindergarten | 78 | 4.47 | 1.38 | | |
| | | S- kindergarten | 157 | 4.52 | 1.31 | | |
| | | T-kindergarten | 27 | 4.71 | 0.99 | | |
| | | U- kindergarten | 208 | 4.37 | 1.23 | | |
| TB | E-B | Master's degree | 11 | 3.82 | 1.25 | 2.19 | |
| | | University | 585 | 4.54 | 1.29 | | |
| | | High school | 29 | 4.28 | 1.35 | | |
| TB | J-T | A-teacher | 14 | 4.60 | 1.05 | 0.31 | |
| | | F- teacher | 50 | 4.67 | 1.24 | | |
| | | S- teacher | 92 | 4.57 | 1.19 | | |
| | | T- teacher | 36 | 4.47 | 1.54 | | |
| | | U- teachers | 433 | 4.49 | 1.31 | | |
| SBR | K-R | D- kindergarten | 155 | 4.14 | 0.83 | 4.02** | 5 < 1*, 2*, 3* |
| | | F- kindergarten | 78 | 4.13 | 0.85 | | |
| | | S- kindergarten | 157 | 4.11 | 0.74 | | |
| | | T- kindergarten | 27 | 3.84 | 0.69 | | |
| | | U- kindergarten | 208 | 3.86 | 0.81 | | |
| SBR | E-B | Master's degree | 11 | 3.47 | 0.97 | | |
| | | University | 585 | 4.04 | 0.79 | 2.81 | |
| | | High school | 29 | 3.95 | 1.06 | | |
| SBR | JT | A- teacher | 14 | 4.38 | 0.63 | 2.48* | 3 < 2* 5 < 2* |
| | | F- teacher | 50 | 4.28 | 0.66 | | |
| | | S- teacher | 92 | 3.98 | 0.74 | | |
| | | T- teacher | 36 | 4.13 | 0.85 | | |
| | | U- teachers | 433 | 3.98 | 0.83 | | |

*$p < 0.05$; **$p < 0.01$, same following.

*K-R, kindergarten rank; E-B, educational background; J-T, job title; TA, teaching ability; TB, teaching belief; D, demonstration; A, advanced level; F, first-level; S, secondary-level; T, third-level; U, unrated; High school (including vocational and technical secondary school); University (including junior college and undergraduate); Master's degree, Master's degree and above.*

**TABLE 2 |** The correlation matrix of SBR, teaching beliefs, and teaching abilities.

| variable | M | SD | J-T | Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-T | – | – | | | | | | | | | | | | | |
| Age | 26.61 | – | – | – | | | | | | | | | | | |
| 1 | 4.02 | 0.81 | −0.10* | 0.09* | – | | | | | | | | | | |
| 2 | | 0.89 | −0.12** | 0.12** | 0.86** | – | | | | | | | | | |
| 3 | | 0.91 | −0.05 | 0.05 | 0.93** | 0.79** | – | | | | | | | | |
| 4 | | 0.88 | −0.13** | 0.11** | 0.91** | 0.74** | 0.79** | – | | | | | | | |
| 5 | | 0.88 | −0.06 | 0.05 | 0.88** | 0.67** | 0.79** | 0.74** | – | | | | | | |
| 6 | | 0.90 | −0.08* | 0.08 | 0.92** | 0.71** | 0.80** | 0.81** | 0.82** | – | | | | | |
| 7 | 4.51 | 1.29 | −0.04 | −0.03 | 0.39** | 0.35** | 0.35** | 0.33** | 0.42** | 0.35** | – | | | | |
| 8 | 3.38 | 2.04 | 0.01 | −0.09* | 0.14** | 0.13** | 0.14** | 0.07 | 0.22** | 0.11** | 0.90** | – | | | |
| 9 | 5.93 | 1.26 | −0.10* | 0.12** | 0.62** | 0.54** | 0.52** | 0.62** | 0.52** | 0.59** | 0.49** | 0.06 | – | | |
| 10 | 5.61 | 1.15 | −0.13* | 0.17** | 0.64** | 0.53** | 0.55** | 0.60** | 0.57** | 0.62** | 0.33** | 0.10* | 0.57** | – | |
| 11 | 5.49 | 1.16 | −0.12** | 0.17** | 0.62** | 0.52** | 0.53** | 0.57** | 0.56** | 0.60** | 0.34** | 0.12** | 0.54** | 0.98** | – |
| 12 | 5.74 | 1.20 | −0.13** | 0.16** | 0.63** | 0.52** | 0.54** | 0.60** | 0.56** | 0.61** | 030** | 0.06 | 0.56** | 0.97** | 0.91** |

*$p < 0.05$; **$p < 0.01$, 1 = SBR (total); 2 = SP; 3 = CA; 4 = CFSL; 5 = DPR; 6 = RD; 7 = TB (total); 8 = TTC; 9 = CTC; 10 = TA (total); 11 = T; 12 = O.*

activities, focus on children's learning and development, sharing practices, and reflective dialog) were used as independent variables, preschool teachers' teaching ability was used as the dependent variable, and the forced input method was used to perform linear regression analysis.

**Table 3** shows that in the regression model of SBR level and teaching ability, the adjusted $R^2$ value is 0.41, indicating that the predictive power of SBR level on preschool teachers' teaching ability reaches 41%. At the same time, the value of the standardized coefficient β is 0.64 (a positive value), and the value of t is 20.65 ($p < 0.001$), indicating that the level of SBR has an extremely significant positive predictive effect on preschool teachers' teaching ability. For every additional unit level of SBR, preschool teachers' teaching ability increases by 0.638 units. Therefore, H1 is verified.

**Table 3** shows that in the regression model of the SBR level and teaching beliefs, the adjusted $R^2$ value is 0.15, indicating that the predictive power of the SBR level on preschool teachers' teaching beliefs is 15%. At the same time, the value of the standardized coefficient β is 0.39 (a positive value), and the value of t is 10.71 ($p < 0.001$), indicating that the level of SBR has an extremely significant positive predictive effect on preschool teachers' teaching beliefs, and for every additional unit of SBR, preschool teachers' teaching beliefs increase by 0.39 units. Therefore, H2 is verified.

**Table 3** shows that in the regression model of teaching beliefs and teaching ability, the adjusted $R^2$ value is 0.11, indicating that the predictive power of preschool teachers' teaching beliefs on preschool teachers' teaching ability is 11%. Furthermore, the value of the standardized coefficient β is 0.33 (the value is a positive number), and the value of t is 8.65 ($p < 0.001$), indicating that preschool teachers' teaching beliefs have an extremely significant positive predictive effect on their teaching ability. For every additional unit of teaching beliefs, teaching ability increases by 0.33 units. Therefore, H3 is verified.

In addition, in the regression model of each dimension of teaching beliefs and teaching ability, the adjusted $R^2$ value is 0.32, indicating that the predictive power of preschool teachers' teaching beliefs on their teaching ability reaches 32%. The value of the standardized coefficient β of CTBs is 0.56 (a positive value), and the t value is 16.99 ($p < 0.001$), indicating that CTBs can significantly predict preschool teachers' teaching ability, while the predictive effect of traditional teaching beliefs on preschool teachers' teaching ability does not reach a significant level. Specifically, for every additional unit of CTBs, preschool teachers' teaching ability increases by 0.56 units.

## Test of the Mediating Effect

From the above correlation analysis and regression analysis, it can be seen that the level of SBR, preschool teachers' teaching beliefs and their teaching ability have significant effects (hypotheses H1, H2, and H3 in this research are supported). Furthermore, the SBR level and teaching beliefs play a significant positive role in predicting preschool teachers' teaching ability. In view of this, we explore whether the level of SBR in kindergarten directly affects preschool teachers' teaching ability through preschool teachers' teaching beliefs, which indirectly affect their teaching ability, to further understand the process by which the level of SBR affects preschool teachers' teaching ability. Based on hypothesis H4, this research tests the mediating effect of preschool teachers' teaching beliefs on the relationship between the SBR level and preschool teachers' teaching ability.

Because traditional teaching beliefs and CTBs among preschool teachers are variables with opposite directions, the two dimensions of preschool teachers' teaching beliefs are established to test the mediation effect. The results show that (1) the mediating effect of traditional teaching beliefs on the SBR level and preschool teachers' teaching ability is not significant (the confidence interval includes zero) and (2) the mediating effect of CTBs on the SBR level and preschool teachers' teaching ability is significant (the confidence interval does not include zero). The mediating effect of CTBs is as follows.

To test the mediating effect of CTBs in preschool teachers' teaching beliefs on the SBR level and preschool teachers' teaching

**TABLE 3 |** Regression analysis results of SBR level, teaching ability and teaching beliefs ($N$ = 625).

| Dependent variable | Independent variable | B (Unstandardized regression coefficient) | SE (Standard error) | Adjusted $R^2$ | $\Delta R^2$ | β (Standardized regression coefficient) | *t* |
|---|---|---|---|---|---|---|---|
| TAs | SBR | 0.91 | 0.04 | 0.41 | 0.41 | 0.64 | 20.65*** |
| TB | SBR | 0.63 | 0.06 | 0.15 | 0.16 | 0.39 | 10.71*** |
| TAs | TB | 0.29 | 0.03 | 0.11 | 0.11 | 0.33 | 8.65*** |
| | TTB | 0.03 | 0.02 | 0.32 | 0.32 | 0.06 | 1.82 |
| | CTB | 0.52 | 0.03 | | | 0.56 | 16.99*** |

***$p < 0.001$.

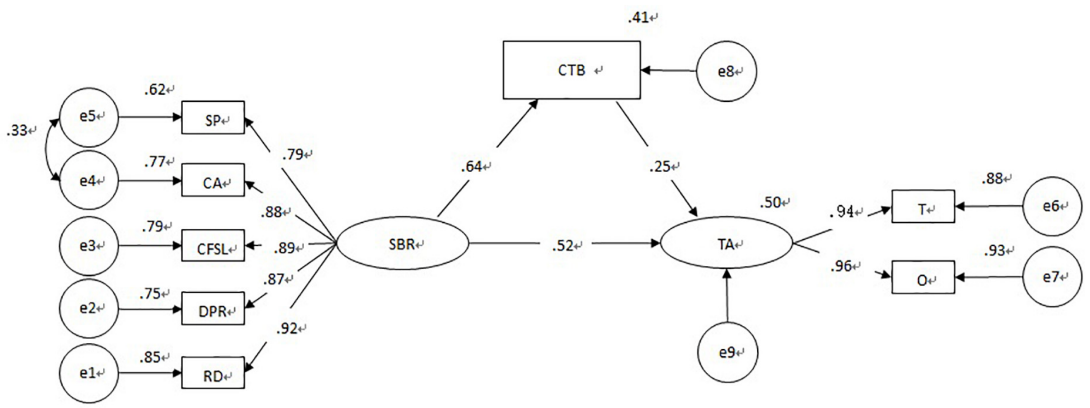


**FIGURE 1 |** A model diagram of the mediating effect of CTBs.

ability, this study uses Amos 23.0 to take the SBR level and its various dimensions as independent variables. Taking preschool teachers' teaching ability and its various dimensions as dependent variables and taking the constructivist dimension of preschool teachers' teaching beliefs as mediating variables, we construct a structural equation model (as shown in **Figure 1**) to test the mediating effect. According to the specific operating procedures, the sample size is set to 5,000, the confidence interval is set to 95%, and the calculation is performed. The analysis of the CTB mediation model shows that it has a good fit (**Table 4**).

First, with regard to the SBR level in kindergarten, preschool teachers' teaching beliefs and teaching ability models (**Table 5**), the total effect between the SBR level and preschool teachers' teaching ability is 0.68, and the Z value is 16.54, which is significantly greater than 1.96. The bias-corrected 95% confidence interval (CI) is (0.60, 0.75), and the percentile 95% CI is (0.60, 0.75). Neither contains 0, indicating that the total effect of the SBR level on kindergarten and preschool teachers' teaching ability is significant.

**TABLE 4 |** The fit index.

| Index | $X^2$/df | RMSEA | CFI | NFI | RFI | TLI | IFI |
|---|---|---|---|---|---|---|---|
| Good | ≤3 | ≤0.08 | ≥0.9 | ≥0.9 | ≥0.9 | ≥0.9 | ≥0.9 |
| Acceptable | ≤5 | ≤0.10 | ≥0.8 | ≥0.8 | ≥0.8 | ≥0.8 | ≥0.8 |
| SBR | 2.70 | 0.09 | 0.96 | 0.93 | 0.92 | 0.95 | 0.97 |
| Teaching ability | 2.48 | 0.09 | 0.97 | 0.95 | 0.95 | 0.97 | 0.97 |
| Teaching belief | 2.80 | 0.09 | 0.97 | 0.96 | 0.95 | 0.97 | 0.97 |
| Mediating model | 4.9 | 0.8 | 0.99 | 0.98 | 0.97 | 0.98 | 0.97 |

Second, the indirect effect of preschool teachers' CTBs between the SBR level and preschool teachers' teaching ability is 0.16; the Z value is 3.88, which is significantly greater than 1.96; and the bias-corrected 95% CI is (0.09, 0.25). The percentile 95% CI is (0.09, 0.25), and neither contains 0, indicating that preschool teachers' CTBs have a significant indirect effect between the SBR level in kindergarten and preschool teachers' teaching ability.

Third, after controlling for the influence of teaching beliefs in the intermediate variables, the direct effect of the SBR level and preschool teacher's teaching ability is 0.52, and the Z value is 9.61, which is significantly greater than 1.96. The bias-corrected 95% CI confidence interval is (0.41, 0.62), and the 95% CI is (0.41, 0.62), neither of which contains 0, indicating that the direct relationship between the level of SBR and preschool teachers' teaching ability is significant.

Finally, preschool teachers' CTBs have a mediating effect between the SBR level and preschool teachers' teaching ability (hypothesis H4 in this study is partially established), and the indirect effect accounts for 23.5% of the total effect. That is, the level of SBR directly affects teaching ability and indirectly affects teaching ability by affecting preschool teachers' teaching beliefs.

In summary, of the four research hypotheses in this study, H1, H2, and H3 are verified, and H4 is partially verified (**Figure 1**); that is, the SBR level, teaching beliefs and

**TABLE 5 |** The mediating role of the CTBs bootstrap test (SBR—TAs).

| | Point estimate | Product of coefficient | | Bias-corrected 95% CI | | Percentile 95% CI | |
|---|---|---|---|---|---|---|---|
| **Effect** | | **SE** | **Z** | **Lower** | **Upper** | **Lower** | **Upper** |
| Total effect | 0.68 | 0.04 | 16.54 | 0.60 | 0.75 | 0.60 | 0.75 |
| Indirect effect | 0.16 | 0.04 | 3.88 | 0.09 | 0.25 | 0.09 | 0.25 |
| Direct effect | 0.52 | 0.05 | 9.61 | 0.41 | 0.62 | 0.41 | 0.62 |

$^{***}p < 0.001$.

teaching ability are all significantly correlated, and preschool teachers' CTBs played an intermediary role between SBR and preschool teachers' teaching ability. Therefore, the level of SBR not only directly affects preschool teachers' teaching ability but also indirectly affects teaching ability by influencing teachers' CTBs.

# DISCUSSION AND ANALYSIS

## The School-Based Research Level Has Been Greatly Improved

In this study, the level of kindergarten-based teaching and research reached the upper-middle level ($M$ = 4.02), which is different from the "low efficiency and formality of kindergarten-based teaching and research" and "poor level of kindergarten-based teaching and research" mentioned by some researchers (Li, 2006; Liu, 2010; Lu, 2011). In approximately 2005, due to the low quality of kindergarten teachers and the overall low level of kindergarten management, the level of kindergarten-based teaching and research was low. However, after 15 years of development and the standardization of the kindergarten management system, the quality of kindergarten-based teaching and research have been ensured. In particular, the quality of kindergarten teachers has greatly improved, and kindergartens themselves have been equipped with high-level teaching and research staff. This teaching and research involves a higher level of learning community.

First, SBR is based on the existence of a certain community (Zhang and Zhu, 2005; Huang, 2017). Currently, SBR is generally equipped with a higher-quality learning community. Researchers suggest that many preschool teachers in China have not previously received professional training (Pang, 2019). For example, among preschool teachers in Beijing in 2010–2015, nearly 40% of young teachers had a technical secondary school education or below (Feng et al., 2017). In 2013, the preschool teachers in Sichuan Province were similar to this level. In Sichuan Province, the percentage of full-time preschool teachers with a high school education and below is 32.33%, and 67.67% of preschool teachers have a university degree or above, which means that more than 30% of preschool teachers do not meet the educational standard.

With the attention of the Chinese government, the number of preschool teachers in China has steadily increased, and the professional level has improved (Yu and Zhang, 2018), which is mainly reflected in the great improvement of preschool teachers' academic qualifications and profession (Gao and Wang, 2014).

In 2020, there were 2,913,400 full-time preschool teachers in China, an increase of 150,300 over the previous year (5.44% increase) (Ministry of Education in China, 2020). The ratio of teachers with a high school degree and below was 14.25%, which is less than 20%, and 80% of teachers had a college degree or above.

In 2020, the number of full-time preschool teachers in Sichuan Province with a high school degree or below dropped to 9.39% (13876/147849). That is, more than 90% of preschool teachers had a college degree or above (90.61%). In this study, the proportion of preschool teachers with a college degree or above accounted for more than 90% (**Table 1**). Among all the teachers, preschool teachers majoring in preschool education accounted for 88.3%. The improvement in the quantity and quality of preschool teachers provides a good foundation for SBR.

Second, the standardized management of kindergartens provides a guarantee for the quality of SBRs. Since 2010, China has issued many policies and documents related to ECE to standardize and guide the development of kindergartens and to ensure the quality of ECE, such as "Qualification Standards for Principals," "Professional Standards for Preschool Teachers," and "Guidelines for the Development of Children from 3 to 6 Years Old." In the "Kindergarten Work Regulations," various safety systems for kindergarten operations are clearly proposed. Local governments have also equipped professional management personnel, such as county-level preschool education teachers and researchers, to ensure business exchanges in county kindergartens. The "Criteria for the Appointment of the Principal" strengthens admission standards to ensure the normal operation of kindergartens. The "Kindergarten On-the-Job Training Curriculum Standards" and "Several Opinions of the State on the Reform of Early Childhood Education" clearly propose requirements for teacher on-the-job training and SBR. The forthcoming "Preschool Education Legislation Draft" also proposes standards for SBR. In approximately 2005, researchers felt that SBR in kindergarten was inefficient and formalized (Li, 2006; Liu, 2010; Lu, 2011). After years of hard work, with the standardization of the kindergarten management system, the quality of SBR in kindergarten has been ensured.

School-based research is more standardized in the selection and training of principals than teachers. The "Qualification Standards for Principals" have been issued in China to strengthen the barriers to entry for principals. At the same time, these

standards attach importance to the training of principals and key teachers and the quality of training courses. As the government attaches emphasizes the training of principals and expert teachers, the problem awareness and research capabilities of principals and key teachers have been significantly improved (Jiao, 2020). Although there is still theoretical content in the training, the training also includes analysis of the problems of the kindergarten and the kindergarten's future development plan. The principals and expert teachers who receive the training pay more attention to the problems of the kindergarten and the practice of theories in ECE. During the training, visits to different types of kindergartens and reflection and dialog with different principals promote principals' reflective thinking and open consciousness. In this context, the guidance of county-level teachers and researchers promotes exchanges between different kindergartens in the county and provides a basis for demonstration and research for the in-depth study of problems in kindergartens.

Third, changes in the form and content of SBR have improved the effectiveness of SBR. In the process of China's educational development, teachers' continuing education has always been valued. Especially since 2010, a diverse preschool teacher training system with rich content has been formed in China, including workshops, SBR, and a coaching system. Training attaches great importance to the participation of preschool teachers (Huang, 2017). This series of changes highlights the central position of teachers in training (Zhu and Chang, 2018). In particular, SBR focusing on practical problems in kindergartens has transformed preschool teachers from passive learners in traditional training to researchers, reflectors, and learning leaders. The role of preschool teachers has undergone a fundamental change (Chen, 2017), and the dominant position of kindergarten teachers in SBR has been highlighted.

Guidance from theoretical knowledge is critical to training for preschool teachers, but more importantly, such training pays attention to the connection between theory and practice and the solution of practical problems. In particular, researchers reflect on the content of SBR and the effects of training to promote training at all levels and to promote SBR to emphasize practical knowledge and practical problems in kindergartens (Li, 2011). Training for kindergartens clearly shows two trends: the first involves increasing the connection with practice in kindergartens and promoting the connection between theory and practice in kindergartens, while the second involves increasing reflection and improvement.

Under the guidance of local preschool researchers and driven by expert teachers and model kindergartens, exchanges among county-based preschool teachers have formed a regular system, and expert preschool teachers have the courage to show others their practice and exploration in ECE. This provides a good research atmosphere for SBR. The promotion of the famous teacher studio system has deepened the connection between ECE theory and kindergarten practice and promoted an atmosphere of reflection and discussion in all kindergartens. After 2015, the expert teacher studio system was launched in various places. On the one hand, it has strengthened the connection among kindergartens and promoted the construction of the kindergarten learning and practice community. On the other hand, the expert teacher studio system has focused on the practice of kindergartens and strengthened the relationship between theory and practice. Effective convergence, to a certain extent, also provides a model for SBR. The expert teacher studio system focuses on the practice of kindergartens and strengthens the effective connection between theory and practice while providing a model for SBR in each kindergarten.

In addition, in various workshops led by expert teachers, preschool teachers encounter problems in practice as the research content. Through the "community" in the workshops, preschool teachers and local kindergartens can think collaboratively. Opportunities for practical contact increase opportunities for joint reflection and improve the various abilities of participating teachers. Under the guidance of expert teachers, preschool teachers become good at speaking, reflecting, and innovating.

## The School-Based Research Level Can Positively Predict Teaching Beliefs and Teaching Abilities

According to *professional learning community* theory, SBR that closely reflects the actual kindergarten situation can change teachers' beliefs (Imants et al., 2001; Shulman and Sherin, 2004). Since the real problems of kindergartens involve the content of their teaching and research activities to promote solutions to the actual problems of ECE (Wu, 2021), SBR draws upon teachers' previous experiences, increases teachers' recognition of research and training, promotes teachers' reflection, and enhances teachers' teaching beliefs. Furthermore, it promotes the improvement of preschool teachers' teaching ability, which shows a positive correlation between SBR, teaching beliefs and teaching ability, supporting the views of some researchers (de Vries et al., 2013; Chen and Zhang, 2014; Chaaban, 2017; Hursen and Islek, 2017; Kim, 2017; Yin et al., 2019; Keung et al., 2020; Sim and Miai, 2021).

However, these findings are inconsistent with the views of some studies. Some researchers believe that the SBR level is relatively low and cannot promote a change in preschool teachers' beliefs and an improvement in teaching behavior (Li, 2006; Liu, 2010; Lu, 2011), which should be related to the SBR level or working mechanism. The advantage of ideal SBR is the sharing of practical situations (Chen and Zhang, 2014; Liang and Xin, 2015). It is difficult to transform teaching concepts into teaching abilities, but when combined with school practice, teachers' experience can be utilized, and teachers can transform their concepts into self-monitoring abilities (Xin et al., 1997). Therefore, the function of SBR should be established based on shared practice. Only by combining the actual shared practice of ECE in kindergarten can teaching beliefs be transformed into teaching behaviors.

## In the Context of Shared Goals and Cooperative Activities, Teaching Beliefs Can Positively Predict Teaching Ability

Since the reform of ECE in China is basically guided by constructivist theory, the focus on the central position of children

and the emphasis on the value of play causes SBR to attach importance to the subjective status of children and the role of play to further deepen teachers' CTBs (Louis and Marks, 1998). Additionally, because the content of SBR combines the practical problems of kindergartens, preschool teachers can organically combine teaching beliefs with teaching practice. Similarly, some researchers believe that teaching ability and teaching beliefs are significantly positively correlated (Mohamed and Al-Qaryouti, 2016; Kim, 2017; Sim and Miai, 2021).

This view is different from the weak correlation that some researchers have found (Schachter, 2015; Huang and Zhang, 2019). Huang and Zhang (2019) suggested that there is a weak correlation between teaching beliefs and teaching behaviors. The main reason for this is that teaching behavior and teaching ability are not the same concept, and their focuses are different. Teaching ability in this study mainly focuses on teaching and organization, while teaching behaviors involve emotional support, class management, and educational support (Huang and Zhang, 2019). Since the teaching behavior of preschool teachers is affected not only by preschool teachers' own ability but also by the kindergarten environment and other factors, whether teaching ability is completely transformed into teaching behavior remains to be further studied.

### Constructivist Teaching Beliefs Play a Part in the Mediating Role Between SBR and Preschool Teachers' Teaching Behaviors

Researchers believe that school-based training can effectively change teachers' beliefs due to problematic situations and teachers' reflections (Yang, 2010). In child-centered and play-centered curricula, teachers' constructivist beliefs have a positive effect (Sim and Miai, 2021). This positive effect is mainly reflected in the impact on behavior (Mohamed and Al-Qaryouti, 2016; Kim, 2017). Therefore, SBR guided by constructivist theory can change the teaching beliefs of preschool teachers and generate changes in teaching behavior. In this study, the indirect effect of preschool teachers' constructivist beliefs between SBR and teaching ability accounted for 23.5% of the total effect (**Table 5**), indicating that teachers' teaching beliefs played a mediating role between SBR and teaching ability. The direct impact of SBR on the teaching behavior of preschool teachers was 76.5%. Traditional teaching beliefs have no mediating effect on the relationship between SBR and teachers' teaching ability.

## CONCLUSION AND SUGGESTIONS

### Conclusion

School-based research is a systematic project that focuses on the core of the quality of ECE, which emphasizes play as the main form of learning and the central position of children (Teo and Zhou, 2017; Papadakis and Kalogiannakis, 2020; Papadakis, 2021), develops a series of research forms and systems, and provides a good foundation for the development of SBR to improve the level of SBR.

(1) SBR in China has reached the upper-middle level. There is a diverse preschool teacher training system with rich content in China, including workshops, SBR, and a coaching system.

In such a teacher training system, due to the great importance attached to the guiding role of experts and local officials and the emphasis on kindergarten practice, SBR has played an important role in promoting the professional growth of teachers and the construction of the kindergarten curriculum, and it has shown a high level.

(2) The SBR level can positively predict preschool teachers' teaching beliefs and teaching abilities. In China, SBR focusing on practical problems in kindergartens has transformed preschool teachers from passive learners in traditional training to researchers, reflectors, and learning leaders, enabling teachers to think about practice in ECE. Preschool teachers' research ability and habits have improved. When teachers apply these abilities to practice, they continue to improve their teaching ability. These reflective habits and the democratic atmosphere formed in workshops are transferred to SBR, which drives more teachers to participate.
(3) The constructivist beliefs of preschool teachers play an intermediary role between SBR and teaching ability. The impact of SBR on teachers' teaching ability occurs in two ways: indirect and direct impacts. In this study, the direct impact of SBR on the teaching behavior of preschool teachers accounted for 76.5% of the total effect, and the indirect effect accounted for 23.5%; preschool teachers' constructivist beliefs played a mediating role in the relationship between SBR and teaching ability *via* an indirect effect.

### Suggestions

Since there are two mechanisms by which SBR affects preschool teachers' teaching ability, there are two ways to promote teachers' teaching abilities.

(1) SBR should be developed based on the practice of ECE in kindergartens to promote improvement in the teaching ability of kindergarten teachers.
(2) The role of preschool teachers' beliefs should be considered; the purpose of influencing preschool teachers' teaching abilities can be achieved by changing teachers' teaching beliefs.

### Implications

There are still some deficiencies in this study, especially in terms of the methods. First, the subjects of the questionnaire were only from one province in China; thus, the study's representativeness is not sufficient, and the sample size is

relatively limited. Second, only questionnaires were used, and no interviews were conducted with relevant preschool teachers or principals. Third, in terms of the research design, this study was only a cross-sectional study and not a longitudinal controlled experiment, indicating that the research method was not perfect.

## DATA AVAILABILITY STATEMENT

The data and material used during the current study are available from the corresponding author (ZY) on reasonable request.

## AUTHOR CONTRIBUTIONS

ZY and SZ were responsible for the design of the study. ZY was responsible for writing and revision of the manuscript. SZ was responsible for the data analysis. Both authors contributed to the article and approved the submitted version.

## FUNDING

This work was supported by the National Social Science Foundation of China (Grant No. 19BSH049).

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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ORIGINAL RESEARCH
published: 30 May 2022
doi: 10.3389/feduc.2022.889116

# Developing Preschool Teachers' Computational Thinking Knowledge, Attitudes, Beliefs, and Teaching Self-Efficacies: A Curriculum-Based Professional Development Program

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Grounded in transformative teacher development through the curriculum-based professional learning (CBPL) approach to teaching-learning, this exploratory study surveyed the computational thinking (CT) views of 25 in-service teachers before and after their CT professional development programme workshops. *Multivariate outcome multilevel cross-classification analysis* showed that after their workshops, these teachers changed their CT knowledge, CT attitudes, CT beliefs, and CT teaching self-efficacy. Teachers reporting greater CT knowledge than others felt greater overall CT teaching self-efficacy, including for both plugged and unplugged CT activities. Moreover, teachers who reported a school culture of sharing and teamwork or sufficient school resources for CT activities were more likely than other teachers to have greater teaching self-efficacy for plugged CT activities or CT activities overall. These results highlight the importance of school culture, school technology resources, and teachers' reported CT knowledge to their CT teaching self-efficacy.

**Keywords: computational thinking, curriculum-based professional learning, learning design, preschool teachers, early childhood education, attitudes, beliefs, teaching self-efficacy**

OPEN ACCESS

***Edited by:***
*Hui Li,*
*Shanghai Normal University, China*

***Reviewed by:***
*Nicole D. Anderson,*
*MacEwan University, Canada*
*Lawrence Jun Zhang,*
*University of Auckland, New Zealand*

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***Specialty section:***
*This article was submitted to Educational Psychology, a section of the journal Frontiers in Education*

***Received:*** *03 March 2022*
***Accepted:*** *27 April 2022*
***Published:*** *30 May 2022*

***Citation:***
*Saxena A and Chiu MM (2022) Developing Preschool Teachers' Computational Thinking Knowledge, Attitudes, Beliefs, and Teaching Self-Efficacies: A Curriculum-Based Professional Development Program. Front. Educ. 7:889116. doi: 10.3389/feduc.2022.889116*

## INTRODUCTION

As computational thinking (CT) become increasingly important to more jobs (Bull et al., 2020), more countries are incorporating CT into their school curricula often mandatory (Gretter and Yadav, 2016; Sands et al., 2018; Li et al., 2020). However, early childhood education (ECE) research on CT is still in its infancy (Angeli et al., 2016), with no consensus on the definition of CT or how to teach it in ECE. Still, educators generally agree that professional development is crucial to helping teachers teach with CT activities (Barr and Stephenson, 2011; Bower et al., 2017; Yadav et al., 2017).

Past studies show that teacher professional development programs (PDP) for CT can help teachers gain an understanding of the subject and foster favorable attitudes toward teaching with CT activities (Hestness et al., 2018; Ketelhut et al., 2020; Rich et al., 2021a), but teachers without prior CT experience acquired only superficial CT understanding (Bower et al., 2017). However, short PDPs (50 min to 6 h) did not increase teachers' beliefs in their ability to plan and execute actions to achieve specified goals (*self-efficacy,* Bandura, 1977), change their negative beliefs about CT

(Rich et al., 2021a), or adequately prepare teachers to teach with CT activities (Bower et al., 2017). Hence, teacher PDP to help them develop both CT knowledge and CT teaching effectiveness requires (a) alignment to their CT curriculum (Darling-Hammond and Richardson, 2009), (b) embedding into their teaching (e.g., learn-by-doing, apply CT activities into their teaching; Bayar, 2014; Darling-Hammond and Richardson, 2009 (c) peer support (Villegas-Reimers, 2003; Darling-Hammond and Richardson, 2009; Bayar, 2014), and (d) longer, intensive, ongoing, systematic training (Dori and Herscovitz, 2005; Darling-Hammond and Richardson, 2009). Furthermore, a supportive school culture for the PDP enhances its effectiveness (Avalos, 2011).

Considering these findings from past studies, we proposed, designed and implemented curriculum-based professional learning (CBPL) (Short and Hirsh, 2020), PDP to help 25 teachers integrate CT into their curriculum and teaching (not a stand-alone CT subject). This study explores the impact of this PDP on 25 participating teachers' CT knowledge, attitudes, beliefs, and CT teaching self-efficacy.

# CURRICULUM-BASED PROFESSIONAL LEARNING PROGRAM

We begin with the theoretical framework undergirding the CBPL program. Then, we specify its implementation.

## CBPL Theoretical Framework

According to the CBPL approach, high-quality curricular resources and active instruction experiences help teachers improve their knowledge, attitudes, beliefs, and teaching to improve their students' learning outcomes (Short and Hirsh, 2020). Curriculum-driven professional development is more focused and intentional than otherwise (Wong and Tsui, 2007). Mutually supportive schools, districts, and professional development providers can further improve teachers' teaching (Akinyemi and Nkonki, 2020).

Curriculum-based professional learning includes four design features: core, functional, structural and essential (Short and Hirsh, 2020). Following Mishra and Koehler's (2006) *technological pedagogical content knowledge* (TPACK) framework for teacher knowledge, *core design features* (curriculum, transformative learning, equity) develop preschool teachers' shared understanding of CT concepts and their relevance to daily life, pedagogical content teaching skills, and diverse lesson activities (both plugged and unplugged). Transformative learning experiences introduce new teaching materials (e.g., videos) that teachers use during the PDP and then with young learners in class, thereby helping teachers enhance their perceptions, beliefs, and self-efficacies. To promote equity, the PDP uses culturally and developmentally appropriate integration of CT into ECE.

*Functional design features* of PDP includes learning designs, reflection/feedback, beliefs, and change management. The learning designs introduce CT integrated curriculum with peer teachers, who implement and mirror pedagogical strategies with digital tools to teach CT. Reflection and feedback enhances teachers' practical skills with these tools. As teachers' competences grow, PDP cultivates change in their teaching beliefs. PDP also helps teachers become change agents and manage their changes to enhance their CT integrated classroom practices and scaffold student learning.

*Structural design* provide regularity and increase consolidation of learning. Grounded in constructionist learning theory (Csizmadia et al., 2019), teachers collaborate to plan, implement, and assess new CT teaching materials and lessons for effectiveness and sustainability. Over time, they adapt their teaching practices to their students' needs.

*Essential elements* are leadership, coherence, and resources. PDP helps groups of leaders and teachers develop a shared, long-term vision for school-wide CT integration. Furthermore, they build networks with other schools implementing CT for mutual sharing and support. With sufficient resources, they can build sufficient material (e.g., Beebots) and staff capacity for CT implementation.

## CBPL Implementation

The CBPL training course includes six workshops across 6 months and a summer training institute for participants to apply their workshop ideas to teaching students. The *first* workshop helps teachers understand the critical dimensions of Brennan and Resnick's (2012) CT framework: key ideas (e.g., iteration, parallelism; *computational concepts*), computer scientist actions (e.g., debugging projects; *computational practices*), and computer scientist views of the world (*computational perspectives*). In this workshop, teachers learned about CT components *via* daily life problem-solving activities and a related short video. They learned terms such as "loops," "conditionals," and "variables" within simple computer program structures. Then, they explored links between CT components and the ECE curriculum *via* brainstorming and discussion. Next, they reflected on CT's educational purposes and made recommendations for excellent CT instruction. We encouraged their use of CT within a suitable educational philosophy and ECE learning environment. The first workshop promoted open discussion around questions such as these (rather than simply giving answers):

1). Does young children's involvement in CT activities imply that the ECE learning environment should include CT?
2). If children engage in plugged or unplugged CT-related activities, can we presume that are excited to learn more?

These teachers considered five CT uses.

1. CT to learn recent technological developments (e.g., use CT to teach technology and robotics principles, such as computer programming);
2. Integrated view of CT (e.g., use CT to consolidate understanding in other curriculum areas, such as language, digital literacy, mathematics);
3. Challenge students' thinking (e.g., use CT to strengthen children's capacity to solve problems and plan strategies);

4. Use CT to develop metacognition (e.g., use CT to increase children's capacity to reflect on their learning and extend their scientific inquiry);
5. Address psychological and motivational needs (e.g., use CT as a learning environment to reduce anxiety and fear of mistakes; increase motivation and self-esteem).

The *second* workshop enhanced teachers' pedagogical understanding of computational concepts, practices, and perspectives *via* hands-on practice. Teachers examined data practices, modeling, simulation practices, computational problem-solving practices, and systems thinking activities. To understand and apply these practices to ECE, they collaborated in groups to solve CT problems involving the programming of Beebots, Cubetto, Robo_Wunderland, and ScratchJr (*artifact-based learning, Bairaktarova et al., 2012*).

These teachers also developed "activities . . . to engage a variety of audiences with great ideas from computer science and CT, without learning coding, programming or even using a digital device" (*unplugged CT*, Bell and Vahrenhold, 2018, p. 497; T. Bell et al., 1998). These activities incorporate games, puzzles, stories, challenges, and rich sensory experiences (see examples at Hello Ruby; code.org; ACARA; CS Unplugged, Bell, 2021). Unplugged activities are inexpensive, accessible, and require few resources (Lee and Recker, 2018). Unplugged CT promotes its development by complementing programming, integrating it into other topics, and scaffolding teachers and students, serving as a "priming phase" before programming to increase students' awareness of algorithmic stages (Huang and Looi, 2021). By using familiar materials and concepts, unplugged CT such as paper circuitry activities "provide multiple entry points for students less familiar with computational thinking concepts" to learn algorithmic thinking, conditional logic, debugging, etc. (Lee and Recker, 2018). Lastly, these teachers wrote reflections on how their understanding and teaching of CT changed.

The third workshop cultivates teacher beliefs to support their CT teaching *via* group exploration and application. As participating teachers discuss, understand, implement, and assess CT teaching practices, they appreciate their effectiveness and sustainability, which enhances their beliefs and attitudes about effective CT teaching (Bower et al., 2017; Yadav et al., 2017; Corradini et al., 2018). Notably, they increase their belief in their capacity to act and accomplish teaching goals (*teaching self-efficacy*, Bandura, 2000). They created a bank of design scenarios and resources for teaching and assessing the CT learning of young children. Challenged to develop suitable CT activities for ECE, these teachers created compelling practical application scenarios.

We encouraged these teachers to use a scientific approach to these activities that encourages students to identify a problem, present a hypothesis, conduct an experiment, analyze the results, discuss their perspectives, generalize the findings, and revise accordingly (Merrill, 2002). Below are examples for various age groups based on their usefulness, availability, affordability, and variety in the local market (not tied to any one robotic platform):

Pre-nursery (2–3 years): Unplugged CT.
K1 (3–4 years): Unplugged CT, and Robotics.
K2 (4–5 years): Unplugged CT, Robotics, and Digital apps.
K3 (5–6 years): Unplugged CT, Robotics, Digital apps, and ScratchJr.

Rather than prescribe best practices, our course sought to equip teachers with tools to identify best resources and practices for each plugged or unplugged activity. For example, we revised Kemp's model of instructional design (Kemp, 1985) to highlight nine key elements in each activity's development:

1) Determine specific learning objectives and concerns related to CT.
2) Determine the key features and needs of students to consider while planning CT learning experiences.
3) Develop a clear understanding of the CT lesson content and examine the proposed activity components for CT learning goals.
4) Specify the CT instructional objectives and expected outcomes to design suitable CT activities.
5) Logically present the CT content for each instructional element.
6) Develop CT instructional strategies that facilitate students' attainment of learning objectives and enhance their proficiency.
7) Construct the CT instructional materials and choose the most effective delivery.
8) Develop CT instruments to assess students' progress toward objectives.
9) Select appropriate CT resources (time, materials, and class organization for the activities) to aid in teaching and learning processes.

In the fourth and fifth workshops, groups of teachers collaborated to iteratively design shared CT curricula and lessons for ECE based on their school's available resources and culture; and the capabilities, dispositions, and predispositions of both teachers and students (Seow et al., 2019; Kotsopoulos et al., 2021). In this iterative design, they clarified their representative modeling, CT processes and errors, and students' errors, and then used this information to improve their lessons and curricula (Fields et al., 2019). Based on Kemp's (1985) framework, we designed the CT integration resource bank so that its structure emphasizes the critical CT components for a lesson, including suitable in-house plugged, unplugged and web resources. Teachers in the same grade level collaboratively created lesson plans for CT integration; they identified supportive resources for the CT content, designed a lesson plan, used available materials, and presented it to other teachers (with videos, PowerPoint presentations, documents, and photographs). These complex lesson plans:

- Specified lesson topic/title and grade level of students.
- Described the background and rationale.
- Identified of the objectives and evaluation methods for CT integration.
- Specified the needed resources and timeline.
- Described the use of unplugged or plugged resources.
- Described its implementation.

The fourth and fifth sessions prepared teachers to design a CT instructional project following theoretical orientation (workshop 1), practical training (workshop 2) and exploration (workshop 3). The research team evaluated and analyzed each project, and gave the teachers feedback to help them reflect on possible improvements.

The sixth workshop focused on teacher feedback and a CT integrated curriculum. Specifically, teachers discussed key obstacles to creating and teaching an effective lesson plan. They shared CT teaching experiences, practical examples, and results for young children at various ages.

Using a bottom-up approach, teams of teacher representatives led the other participants to create a CT integrated curriculum (Lassonde and Israel, 2009) and institutionalize it. Teacher representatives developed further learning and teaching resources (plugged and unplugged) to enrich 2 to 6-year-old students' learning activities, conduct reviews of activities associated with age-appropriate CT integration (Bers et al., 2014), shared best practices (Melasalmi and Husu, 2016), and enhanced professional development for colleagues (Kermani and Aldemir (2015). Also, they expanded their teacher networks within and across schools, and strengthened partnerships with community key players to attract support and additional resources for long-term planning (Palts and Pedaste, 2020).

As a result of these CBPL workshops, we expect teachers to improve their CT knowledge, beliefs, attitudes and self-efficacies.

# METHOD

In this study, 25 kindergarten teachers participated in a CT PDP and completed a pre-PDP survey and post-PDP survey. We used a multivariate outcome, multilevel cross-classification to analyze their survey responses: (a) for significant differences across pre- and post-surveys, and (b) to test an explanatory model of their CT teaching self-efficacy.

## Participants

We used a convenience sample. Of the eight invited kindergartens, five kindergartens consented to conduct this PDP. Due to COVID-19 delay, only two kindergartens participated in this 6-month, school-site training programme at different times (February–July 2021: 13 teachers, 1 principal, 1 curriculum coordinator; June–December 2021: 13 teachers, 1 principal, 1 curriculum coordinator). Both kindergartens served 2.2 to 6-year-old students. **Figure 1** explains our participant recruitment strategy and study protocol.

All 25 teachers are qualified and registered ECE teachers in Hong Kong (see demographics in **Table 1**) and consented to participate in this research.

## Procedure

All 25 teachers participated in six, 2-h CT PDP workshop sessions, and then taught CT to students aged two to 6 years during either a 6-week summer school or a 2-week camp. All of them wrote reflections at the end of each workshop. All participants confirmed that they did not engage in other workshops during this time. All teachers responded to pre-workshop surveys, and 21 of them completed the post-workshop survey. All teachers were interviewed after the sixth workshop.

## Data

Statistical power differs across levels. For $\alpha = 0.05$ and an effect size of 0.4, statistical power for 25 people is 0.52 and for 46 survey completions across time is 0.80 (Konstantopoulos, 2008). As this small sample has low statistical power, false negatives are likely, but significant results remain valid.

### Survey

The pre-workshop survey included the following fourteen definitions and thirty-three knowledge altogether forty-seven items.

Teacher beliefs about Computers and Computational Thinking (Rich et al., 2021a) has three subscales: (a) *value beliefs (CT belief*, 2 items; e.g., All students should learn CT); (b) *value beliefs for teaching coding (CT attitude*, 3 items; e.g., Interest in teaching with CT/want to continually improve teaching with CT) and (c) *CT self-efficacy* (7 items; e.g., I am ready to teach plugged/unplugged CT activities). All items had 5 point Likert-type scales, unless indicated otherwise. CT value belief response options ranged from "1-Strongly disagree" to "5-Strongly agree." CT self-efficacy items response options ranged from "1- extremely unconfident" to "5-extremely confident."

The post-workshop survey was identical to the pre-workshop survey, except for these additional open-ended questions:

1. Define computational thinking in your own words.
2. Is it possible to integrate computational thinking into the ECE classroom? Yes/ No.
    a. How would you incorporate computational thinking into your ECE classroom if you answered yes?
    b. If not, why is it so difficult to integrate computational thinking into the classroom?

*Post* is a dichotomous variable that indicates whether the data are from the post-survey (value = 1; otherwise 0 for pre-survey).

### Reflections

In the last 30 min of workshops, 2, 3, 5, and 6, participants were prompted to write a short reflection (200–300 words) about their: (1) understanding of CT developed in this phase, (2) CT integration in ECE and (3) how they perceived the workshop activities as helping (or not contributing) to their understanding after that phase.

### Semi-Structured Interviews

After the last workshop, each teacher individually participated in 30 min, semi-structured interviews with a project leader who asked the following questions:

1) What does CT mean to you?
2) What are your pedagogical strategies for developing ECE students' CT?
3) What technologies can be used to develop Kindergarten students' CT?

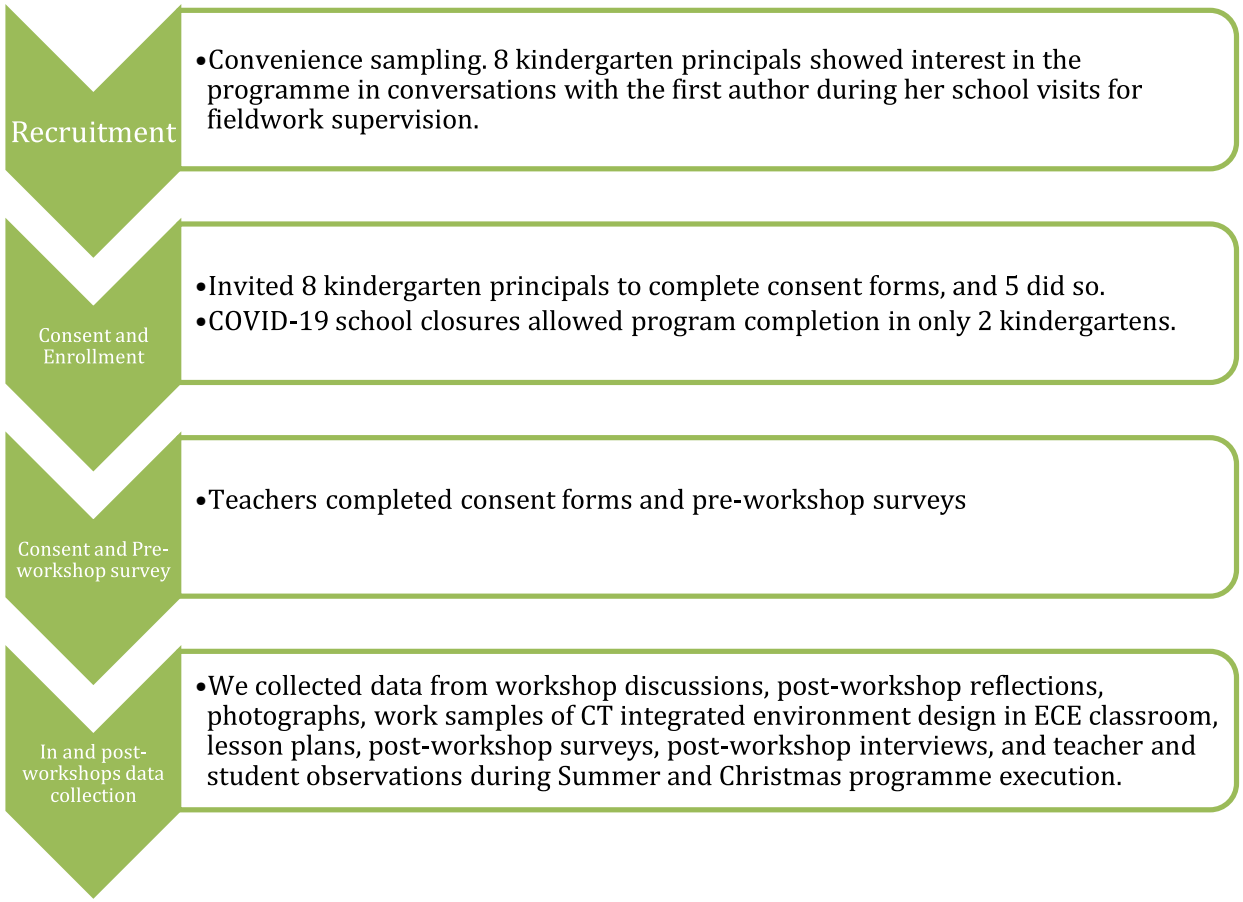


**FIGURE 1 |** Recruitment strategy and study protocol.

4) What prevents you from developing your students' CT?
5) What could help you develop your students' CT?
6) How did participation in these workshops change your view about integrating CT in ECE?

## ANALYSIS

### Survey Analytic Issues and Statistics Strategies

Accurate analyses of these data must address issues involving outcomes and explanatory variables (see **Table 2**).

Outcome issues include differences across teachers or across time, discrete outcomes and multiple outcomes. As completed surveys at the same time or by the same teacher likely resemble one another more than those completed at different times or by different teachers (*cross-classified data*), an ordinary least squares regression underestimates the *standard errors*, so we use a *multilevel cross-classification analysis* (Goldstein, 2011). For ordered discrete outcomes (e.g., ratings), ordinary least squares regressions can bias the standard errors, so we use an *ordered Logit regression* (Kennedy, 2008). To aid understanding of these results, we report the *odds ratio* of the regression coefficient, namely the percentage increase or decrease in the likelihood of the outcome (Kennedy, 2008). Multiple outcomes can have correlated residuals that underestimate standard errors, so we use *multivariate outcome multilevel analysis* (Hox et al., 2017).

Explanatory variable issues include omitted variable bias, indirect effects, cross-level interactions, many hypotheses' false positives, effect size comparisons, and robustness. As unspecified, omitted explanatory variables can cause *omitted variable bias* (Kennedy, 2008), we use a *difference-in-differences analysis* of participants at different times to reduce this bias (Bertrand et al., 2004). Separate, single-level tests of indirect mediation effects on cross-classified data can bias results, so we test for simultaneous multi-level mediation effects with a *multilevel M-test* (MacKinnon et al., 2004).

With cross-classified data, incorrectly modeling interaction effects across levels (e.g., survey response × teacher) can bias the results, so we use a *random effects* model (Hox et al., 2017). If an explanatory variable's regression coefficient (e.g., $\beta_{yvj} = \beta_{yv0} + g_{yvj}$) differs across levels ($g_{yvj} \neq 0$?), then we model the possible cross-level moderation with structural variables (e.g., teacher).

As testing many hypotheses can cause false positives, we reduce them *via* the *two-stage linear step-up procedure*; it outperformed 13 other methods in computer simulations

**TABLE 1 |** Participant's demographics ($N$ = 25).

| Variable | % |
|---|---|
| **Gender** | |
| Female | 84 |
| Male | 16 |
| **Age (years)** | |
| 21–30 | 32 |
| 31–40 | 36 |
| 41–50 | 20 |
| >50 | 12 |
| **Schooling** | |
| University degree | 68 |
| Certificate course | 32 |
| **Years of teaching experience** | |
| <5 years | 20 |
| 6–10 years | 32 |
| 11–15 years | 32 |
| 1620 years | 12 |
| >21 years | 4 |
| **Current students** | |
| PN (2.2–3 years) | 24 |
| K1 (3–4 years) | 32 |
| K2 (4–5 years) | 24 |
| K3 (5–6 years) | 20 |

**TABLE 2 |** Statistics strategies to address each analytic difficulty.

| Analytic difficulty | Statistics strategy |
|---|---|
| **Outcome variables** | |
| • Differences across teachers<br>• Differences across time | • Multilevel cross-classification (Goldstein, 2011) |
| • Discrete variable (yes/no) | • Logit / Probit and odds ratios (Kennedy, 2008) |
| • Multiple outcomes ($Y_1$, $Y_2$, ...) | • Multivariate outcome multilevel analysis (Hox et al., 2017) |
| **Explanatory variables** | |
| • Indirect, multi-level mediation effects (X →M→Y) | • Multilevel *M-test* (MacKinnon et al., 2004) |
| • Cross-level interactions (Time × Teacher) | • Random effects model (Hox et al., 2017) |
| • Many hypotheses' false positives | • Two-stage linear step-up procedure (Benjamini et al., 2006) |
| • Compare effect sizes ($\beta_1 > \beta_2$?) | • Lagrange multiplier tests (Bertsekas, 2014) |
| • Consistency of results across data sets (Robustness) | • Separate multilevel, single outcome models<br>• Analyses of subsets of the data (Kennedy, 2008) |

(Benjamini et al., 2006). When testing whether effect sizes differ, *Wald* and *likelihood ratio* tests do not apply at boundary points, so we use *Lagrange multiplier tests*, which also have more statistical power for small deviations from the null hypothesis (Bertsekas, 2014).

Lastly, we test whether the results remain stable (*robust*) despite small data or analytic differences (Kennedy, 2008). As any mis-specified equation in a multiple outcome model can introduce errors into otherwise correct equations, we model each outcome variable separately. Then, we separately run subsets of the data.

## Pre- vs. Post-workshops Differences

We model each survey response to a question with a *multivariate outcome, multilevel cross-classification* analysis (Hox et al., 2017).

$$\mathbf{Response}_{yit} = \beta_y + e_{yit} + f_{yt} + \beta_{yx}\mathbf{Post}_{yt} \quad (1)$$

In the vector of variables Response, the outcome variable (response to survey question) $y$ by teacher $i$ at time $t$ has a centered intercept $\beta_y$ with unexplained components (*residuals*) at the response- and time-levels ($e_{yit}$, $f_{yt}$). Possible Response outcomes $y$ include define CT (*algorithm, analytic ability, solve as computer scientist, logical, problem solve*), CT knowledge (*know CT, teach CT, teach CT to children, teach unplugged CT*), beliefs (*all learn CT, effective teaching helps students learn CT*), attitude (*interest, improve, attend training*), self-efficacy (*overall CT teaching, plugged CT teaching, unplugged CT teaching*). Then, we test whether teacher responses to questions on the pre-workshops and post-workshops surveys differ, as indicated by the significance of the regression coefficient of Post, namely $\beta_{yx}$ (see summary statistics **Table 3** and the results in **Table 4**).

## CT Teaching Self-Efficacies

Next, we test whether school attributes or teacher characteristics are linked to CT_Teaching_Self-efficacy.

$$\mathbf{CT\_Teaching\_Self\text{-}efficacy}_{yit} = \beta_y + e_{yit} + f_{yt} \quad (2)$$

In the vector CT_Teaching_Self-efficacy, the outcome variable $y$ (*overall CT teaching self-efficacy, plugged CT teaching self-efficacy, unplugged CT teaching self-efficacy*) by teacher $i$ at time $t$ has a centered intercept $\beta_y$ with residuals at the response- and time-levels ($e_{yit}$, $f_{yt}$).

First, we add School variables: *leadership, school culture of sharing and teamwork, sufficient CT resources, technology classrooms,* and *resources for technology training*. Then, we added a time variable: Post. Next, we added teacher beliefs (T_Belief): *all students should learn CT*, and *effective teaching helps students learn CT*. Afterward, we added teacher attitudes (T_Attitude): *interested in teaching with CT*, *continually find better ways to teach CT*, *want more teaching training*. Then, we add teacher knowledge (T_Knowledge): *know CT, know steps for teaching CT, know CT for teaching ECE,* and *know unplugged CT*. Lastly, we added Interaction terms among significant explanatory variables.

$$\begin{aligned}&\mathbf{CT\_Teaching\_Self\text{-}efficacy}_{yit}\\ &= \beta_y + e_{yit} + f_{yt} + \beta_{yis}\mathbf{School}_{yit} + \beta_{yiu}\mathbf{Post}_{yit} + \beta_{yiv}\mathbf{T\_Belief}_{yit}\\ &+\beta_{yiw}\mathbf{T\_Attitude}_{yit} + \beta_{yix}\mathbf{T\_Knowledge}_{yit}\\ &+\beta_{yiz}\mathbf{Interaction}_{yit} \quad (3)\end{aligned}$$

**TABLE 3 |** Summary statistics ($N$ = 46).

| Variable | Mean | SD | Min | Median | Max |
|---|---|---|---|---|---|
| **Define computational thinking (CT)** | | | | | |
| Algorithm | 5.652 | 1.233 | 3 | 6 | 7 |
| Analysis ability | 5.522 | 1.130 | 4 | 6 | 7 |
| Computer program | 5.326 | 1.367 | 2 | 6 | 7 |
| Computer scientist solving process | 5.413 | 1.343 | 3 | 6 | 7 |
| Digital literacy | 4.913 | 1.208 | 2 | 5 | 6 |
| Digital skills | 4.913 | 1.208 | 2 | 5 | 6 |
| Know computer operations | 5.130 | 1.240 | 2 | 5 | 7 |
| Logically organize and analyze | 5.196 | 1.408 | 2 | 6 | 7 |
| Logical problem solve | 5.870 | 1.185 | 4 | 6 | 7 |
| Mathematical thinking | 4.761 | 1.139 | 2 | 5 | 6 |
| Number computations | 5.130 | 1.222 | 2 | 5 | 7 |
| Solve with a computer | 5.174 | 1.768 | 1 | 6 | 7 |
| Systemic thinking | 5.065 | 1.357 | 2 | 5.5 | 7 |
| **CT Belief** | | | | | |
| All students should learn CT | 3.957 | 0.759 | 3 | 4 | 5 |
| Effective teaching improves student learning | 3.913 | 0.812 | 2 | 4 | 5 |
| **CT attitude** | | | | | |
| Interest in teaching with CT | 3.978 | 0.830 | 3 | 4 | 5 |
| Want to continually improve teaching with CT | 3.870 | 0.778 | 2 | 4 | 5 |
| Want more teacher training | 4.109 | 0.737 | 3 | 4 | 5 |
| **CT knowledge** | | | | | |
| Know CT | 4.739 | 1.782 | 1 | 5 | 7 |
| Know how to teach with CT | 3.478 | 0.888 | 1 | 3 | 5 |
| Know how to teach with CT in early childhood lessons | 3.652 | 0.900 | 2 | 4 | 5 |
| Know how to teach with unplugged CT | 3.652 | 0.948 | 2 | 4 | 5 |
| **Teach CT** | | | | | |
| Ready to teach CT activities | 4.783 | 1.725 | 2 | 5 | 7 |
| Ready to teach plugged CT activities | 4.413 | 1.614 | 2 | 5 | 7 |
| Ready to teach unplugged CT activities | 4.717 | 1.721 | 2 | 5 | 7 |

We use an alpha level of 0.05. We also analyze residuals for influential outliers.

## Analysis of Written Reflections and Individual Interviews

We conducted thematic analysis of the written reflections, applying initial coding, axial coding and theoretical coding to identify major patterns and themes (Braun and Clarke, 2006). In the initial coding, data were coded by keywords or phrases (e.g., algorithm, if-then). In the axial coding, the data were coded into categories (e.g., beliefs) and sub-categories (all children should learn CT; only technically-inclined children should learn CT). In the theoretical coding, data were compared with pre-existing models of PDP effects on CT knowledge, beliefs, attitudes, and teaching self-efficacies (e.g., Rich et al., 2021b).

We analyzed the semi-structured interviews (Fraenkel et al., 2015) with Creswell's (2012) six-step method. First, we anonymized and converted all interview transcripts to text. Then, the lead author read the interview transcripts several times to understand the interviewees' ideas and tone. Initial codes were developed and then iteratively refined (Fraenkel et al., 2015). Next, the codes were evaluated, and some were merged while others were deleted. Then, themes were developed and organized into a hierarchy of codes. Tables and figures were created to illustrate the findings. Finally, findings were examined, and thick description and inter-coder reliability tested the trustworthiness of the interpretations.

# FINDINGS

The summary statistics generally showed moderate to high levels of CT knowledge, beliefs, attitudes, and teaching self-efficacies (See **Table 3**), especially on the post-workshop surveys (as shown in the next section). The *multivariate outcome, multilevel cross-classification* results below show significant differences in pre- vs. post-workshops responses, and a path analysis modeling antecedents of CT teaching self-efficacies.

## Pre- vs. Post-workshops Differences

These teachers' survey responses regarding CT definition, beliefs, attitudes, knowledge, and CT teaching self-efficacies showed vast differences before vs. after the workshops. After the workshops, these teachers were far more likely) to define CT as including algorithmic solution of a problem, analytic ability, solving

**TABLE 4 |** Multilevel cross-classification differences analysis.

| Explanatory variable | | | Odds | Explained |
|---|---|---|---|---|
| **Definition of CT** | **b (SE)** | | **ratio** | **Variance (Time)** |
| Algorithmic solution of a problem | 4.867 | *** | 47% | 0.381 |
| | (0.239) | | | |
| Analytic ability | 4.423 | *** | 49% | 0.273 |
| | (1.123) | | | |
| Solving problems as a computer scientist | 3.969 | *** | 48% | 0.231 |
| | (0.880) | | | |
| Logical problem solving | 4.527 | *** | 49% | 0.315 |
| | (0.967) | | | |
| Problem solving | 3.380 | *** | 47% | 0.222 |
| | (0.778) | | | |
| **Knowledge of CT** | | | | |
| Know what CT is | 2.750 | *** | 44% | 0.125 |
| | (0.660) | | | |
| Know steps for teaching CT effectively | 1.783 | *** | 36% | 0.201 |
| | (0.410) | | | |
| Know CT enough to teach it to young children | 3.706 | *** | 48% | 0.245 |
| | (0.874) | | | |
| Know unplugged CT enough to teach it | 4.650 | *** | 49% | 0.301 |
| | (1.138) | | | |
| **Beliefs about CT** | | | | |
| All students should learn CT | 3.995 | *** | 48% | 0.278 |
| | (1.102) | | | |
| Effective teaching helps students learn CT | 1.743 | *** | 35% | 0.082 |
| | (0.619) | | | |
| **Attitude toward CT** | | | | |
| Interested in CT teaching | (4.452) | *** | 49% | 0.338 |
| | 1.118 | | | |
| Continually find better ways to teach CT | (3.901) | *** | 48% | 0.251 |
| | 1.098 | | | |
| Want to attend training about teaching practices | (1.571) | *** | 33% | 0.185 |
| | 0.394 | | | |
| **CT Self-efficacy** | | | | |
| Overall CT teaching self-efficacy | 2.812 | *** | 44% | 0.143 |
| | (0.674) | | | |
| Plugged CT teaching self-efficacy | 3.443 | *** | 47% | 0.180 |
| | (0.742) | | | |
| Unplugged CT teaching self-efficacy | 2.503 | *** | 42% | 0.122 |
| | (0.634) | | | |

****p < 0.001.*

problems as a computer scientist, logical problem solving, or problem solving (+47% or higher odds ratio for each, see **Table 4**). After the workshops, these teachers were much more likely to know what CT is (+44%), know steps to teach CT effectively (+36%), know CT enough to teach it to young children (+48%), and know unplugged CT enough to teach it (+49%). After the workshops, these teachers were also far more likely to believe that all students should learn CT (+48%) and that effective teaching helps students learn CT (+35%). Their following attitudes also vastly improved after the workshops: interest in integrating CT into their teaching (+49%), continually find better ways to teach CT (+48%), and want to attend more training about teaching practices (+33%). After the workshops, teachers reported greater overall CT teaching self-efficacy (+44%), plugged CT teaching self-efficacy (+47%), and unplugged CT teaching self-efficacy (+42%).

## CT Teaching Self-Efficacy

CT teaching self-efficacy often differed more across teachers (teach with CTA overall: 62%; teach with plugged CTA: 64%; teach with unplugged CTA: 50%) than across time (overall CTA: 38%; plugged CTA: 36%; unplugged CTA: 50%; see **Table 5**). (See **Appendix Table A1** for *correlation-variance-covariance matrices*). All results discussed below describe

first entry into the regression, controlling for all previously included variables. Ancillary regressions and statistical tests are available upon request.

## Teachers' Overall CT Teaching Self-Efficacy

School attributes and teachers' perceived knowledge accounted for differences in teachers' overall CT teaching self-efficacy (see **Table 5** and **Figure 2**). Teachers in schools with a culture of sharing and teamwork, in schools with perceived sufficient resources to support CTA, or who viewed themselves as knowing CT were more likely than other teachers to report greater overall CT teaching self-efficacy (respectively, +39%, +32%, +25%).

These results showed significant mediation effects. Teachers in the school with a culture of greater sharing and teamwork were 27% more likely than those in the other school to have sufficient resources to support CTA, which in turn was linked to 32% greater overall CT teaching self-efficacy (12% mediation; $z = 3.15$; $p = 0.002$). In the school with a culture of greater sharing and teamwork, teachers were 27% more likely than those in the other school to view themselves as knowing CT, which in turn was linked to 32% greater overall CT teaching self-efficacy (12% mediation, $z = 2.11$, $p = 0.035$). In the school with greater sufficiency of resources to support CTA, teachers were 21% more likely to view themselves as knowing CT, which in turn was linked to 25% greater overall CT teaching self-efficacy (37% mediation, $z = 2.36$, $p = 0.018$). The final explanatory model accounted for 54% of the differences in overall CT teaching self-efficacy.

## Teachers' Plugged CT Teaching Self-Efficacy

School attributes and teachers' perceived knowledge also accounted for differences in teachers' plugged CT teaching self-efficacy. Teachers in the school with a culture of greater sharing and teamwork or perceived sufficient resources to support CTA, or who viewed themselves as knowing CT were also more likely than other teachers to have greater plugged CT teaching self-efficacy (respectively, +38%, +19%, +24%).

These results also showed significant mediation effects. In the school with a culture of greater sharing and teamwork, teachers were 27% more likely than teachers in the other school to view themselves as knowing CT, which in turn was linked to 24% greater plugged CT teaching self-efficacy (33% mediation, $z = 2.692$, $p = 0.007$). The final explanatory model accounted for 48% of the variance in plugged CT teaching self-efficacy.

## Teachers' Unplugged CT Teaching Self-Efficacy

Lastly, workshop completion and teachers' perceived knowledge accounted for differences in teachers' unplugged CT teaching self-efficacy. Teachers who completed the workshops or viewed themselves as knowing CT were more likely than other teachers to have greater unplugged CT teaching self-efficacy (respectively, +47%, +38%).

These results also showed significant mediation effects. Teachers who completed the workshops were 44% more likely than other teachers to view themselves as knowing CT, and in turn were 38% more likely than other teachers to have greater unplugged CT teaching self-efficacy (37% mediation, $z = 3.204$, $p = 0.001$). The final explanatory model accounted for 78% of the variance in unplugged CT teaching self-efficacy.

All other explanatory variables and interactions were not significant. Analysis of residuals showed no substantial outliers. Robustness tests on data subsets and single outcomes showed similar results.

Our thematic analysis of participants' written reflections and interviews identified important PDP learning components and need for further support.

**TABLE 5 |** Summary of multilevel cross-classification analyses of overall / plugged / unplugged computational thinking teaching self-efficacy.

| | **Computational thinking teaching self-efficacy** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Explanatory variable** | **Overall** | | | | | | **Plugged** | | | | | | **Unplugged** | | | |
| School culture of sharing | 2.04 | *** | 1.79 | *** | 1.57 | *** | 1.95 | *** | 1.89 | *** | 1.27 | ** | | | | |
| And teamwork | (0.39) | +39% | (0.47) | +36% | (0.47) | +33% | (0.40) | +38% | (0.42) | +37% | (0.44) | +28% | | | | |
| School has sufficient | | | 1.55 | *** | 0.97 | * | | | 0.79 | * | 0.82 | * | | | | |
| Resources to support CTA | | | (0.35) | +32% | (0.42) | +23% | | | (0.35) | +19% | (0.38) | +19% | | | | |
| Post-workshops | | | | | | | | | | | | | 3.44 | *** | 2.16 | ** |
| | | | | | | | | | | | | | (0.74) | +47% | (0.83) | +40% |
| Know computational | | | | | 1.12 | * | | | | | 1.04 | *** | | | 1.98 | *** |
| Thinking | | | | | (0.46) | +25% | | | | | (0.31) | +24% | | | (0.40) | +38% |
| **% Variance at each level** | | | | | | | | | | | | | | | | |
| Teacher | 62 | | 62 | | 62 | | 64 | | 64 | | 64 | | 50 | | 50 | |
| Time | 38 | | 38 | | 38 | | 36 | | 36 | | 36 | | 50 | | 50 | |
| **Explained variance at each level** | | | | | | | | | | | | | | | | |
| Teacher | 0.49 | | 0.80 | | 0.86 | | 0.42 | | 0.48 | | 0.53 | | 0.26 | | 0.61 | |
| Time | 0.00 | | 0.00 | | 0.01 | | 0.00 | | 0.00 | | 0.39 | | 0.00 | | 0.95 | |
| Total explained variance | 0.30 | | 0.50 | | 0.54 | | 0.27 | | 0.31 | | 0.48 | | 0.13 | | 0.78 | |

*CTA, computational thinking activities. *p < 0.05, **p < 0.01, ***p < 0.001.*

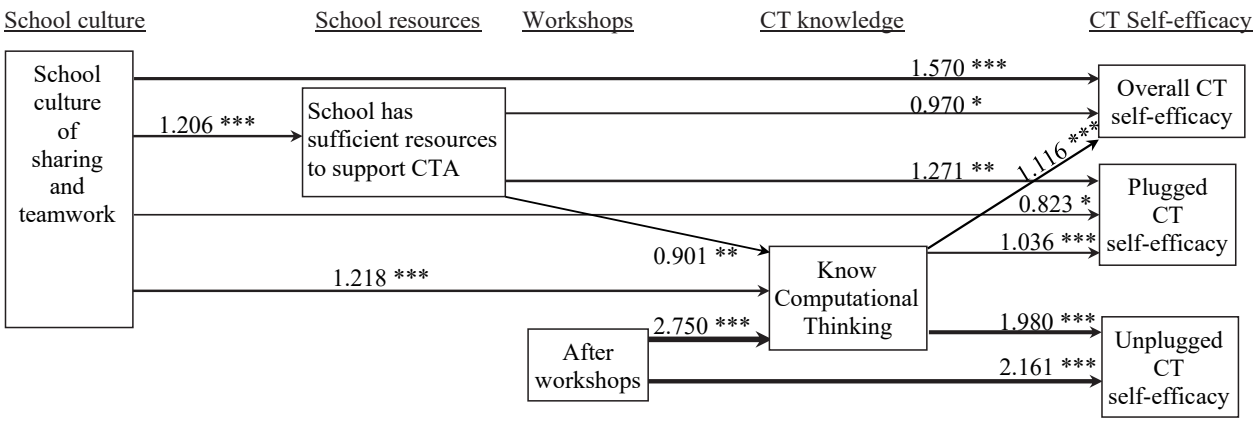


**FIGURE 2 |** Path analysis of antecedents of overall / plugged / unplugged computational thinking (CT) teaching self-efficacy. Thicker arrows indicate larger effect sizes. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ 5.2 Written Reflections and Interviews.

## Valuable PDP Components

Participants identified six valuable PDP components: (a) poor initial CT knowledge, (b) consequent importance of concrete CT experiences, (c) educational resources, (d) collaborative planning, (e) student involvement, and (f) spacing between workshops. Most of these teachers reported no formal training in computers, and many teachers shared teacher T-13's understanding of CT.

> I have never heard about the word "computational thinking" before attending these workshops.
>
> (Teacher-13′s Reflection after the 2nd workshop, T-13-R2).

Like T13, most of these participants had no knowledge of CT.

As a result, many participants like T-17 and T-12 appreciated the informal learning activities.

> Hands-on participation in these PDP workshops made me confident, aware of my own ability to decompose real-world problems. T-17-I(interview) require concrete experience to build the conceptual understanding of CT. T-12-R3.
>
> These teachers explained how their hands-on activities and concrete experiences helped them develop their CT understanding and skills and apply them (e.g., decompose real-world problems).

These teachers' low initial CT competence inclined them toward teaching with unplugged CT activities. For example, T-11 said I love the concept that CT can be implemented through unplugged activities and I am very confident with unplugged pedagogy of teaching CT concepts T-11-I.

> I am going to apply unplugged CT in my class with 3-4-year-old students. T-12-R2.

Like many of these teachers, T-19 and T-12 enthusiastically embraced teaching CT to their young students with unplugged activities. As indicated in the above statistics, teachers reported greater CT teaching self-efficacy for using unplugged rather than plugged activities.

Hence, collaborative planning and the introduction of new education materials and technologies were critical to some teachers using them to teach their students *via* plugged activities. For example, T-9 said:

> Collaborative planning enhanced our collective knowledge of CT and in the future, it will help us to enhance our CT practice through collaborative efforts such as planning, development of resources, assessments etc. T-9-I.

T-9 argued that the collaborative planning both improved their understanding of CT and aids their subsequent CT teaching practices. T-4 explained how she used the provided technologies to teach her students.

> Happy-Map activities are very good when it comes to teaching CT concepts to my K1s, I used Happy-Map step by step guide and next week I introduced the same CT conceptual understanding to find treasure map using Beebots. Students were able to apply the understanding learned through Happy-Map. T-4-R3.

T-4 appreciated the PDP-provided teaching resources (Happy-Map) and technologies (Beebots), using them in her school lessons to help her students learn CT concepts.

T-2-I added:

> The supplied and developed educational material during collaborative planning will help me use the websites etc. to develop my skills further after this training programme.

T-2 reported that the PDP educational material was not only immediately useful but also valuable for her continuing education after completing the PDP.

Like T-4, T-17 and T-24 valued the opportunities to apply their new CT knowledge and teaching skills directly to student lessons to help them learn.

> This is not only to enhance their logical thinking but also to give them opportunities to develop higher-order thinking skills through CT. For example, when I asked one of my K3 students using Cubetto, what to do when we finish our command buttons. The student replied start using numbers for the commands

> that need to repeat so that we can reach treasure without losing command buttons. It was exactly the "loop" conceptual understanding of CT. T-17-I.

T-17 appreciated how her students developed higher-order thinking skills *via* CT activities with Cubetto, as illustrated *via* her students' loop *understanding* and *application*.

T-24 highlighted the importance of such opportunities between workshops.

> I have learned more and clarified my concepts as I get a chance to use the learned new knowledge through workshops in practice for a couple of weeks after workshops. This has given me a chance to reflect on practice and ask for clarification to consolidate my understanding before the next workshop. T-24-R6.

The long spacing between workshops offered these teachers the opportunities to apply their CT teaching to their students, reflect on the results, ask for help and consolidate their understanding before additional learning in the next workshop.

### Need for Further Support

Still, these teachers highlighted the need for additional support, including time, management, resources, networking across schools, and parent understanding. T-9 highlighted the importance of time.

> Time for planning and execution is the most crucial aspect as we lack experience and understanding required to execute CT. After implementation of CT integrated activities in short summer camp will help us to enhance our practice. T-9-R5.

T-9 appreciated the valuable time used for planning and implementing lessons during summer camp, especially as novices.

T-16 noted the importance of management and resources.

> It is necessary to have management onboard to provide us budgetary solutions as our school lacks robots and digital devices to develop plugged CT. T-16-R6.

As T-16 notes, supportive managers can provide budget funding to buy needed CT resources such as robots and digital devices.

Also, T-2 argues for the importance of networking.

> Networking support with other kindergartens integrating CT in practice will be an additional way for continues development of CT enhanced curriculum. T-2-I.

Specifically, T-2 noted that networking with other schools teaching CT can support their continuing CT development, especially of their curricula.

Outside school, T-23 pointed out the importance of parents.

> Development of parental understanding alongside with teacher development is equally important. We will be bringing parents onboard for CT enhanced practices. T-23-I.

T-23 highlighted the value of parental support, and will engage them to back their CT teaching.

## DISCUSSION

This exploratory study examined the effects of a curriculum-based professional learning (CBPL) professional development program on 25 in-service teachers' views of computational thinking (CT). After the workshops, their CT understanding, CT beliefs, CT attitudes, and CT self-efficacies improved both significantly and substantially. Among these teachers, those who reported a stronger school culture of sharing and teamwork, or sufficient school resources for CT activities showed greater CT self-efficacies. Teachers reporting greater CT knowledge had greater CT self-efficacies.

## Pre- vs. Post-workshop Differences

The result suggest that these workshops changed not only these teachers' CT knowledge and CT attitudes but also their CT beliefs and CT teaching self-efficacies.

### CT Knowledge

After completing the workshops, these teachers were far more likely to define CT as including an algorithmic solution of a problem, analytic ability, solving problems as a computer scientist, logical problem solving, or general problem-solving. So, after the workshops, these teachers were much more likely to believe that they knew (a) what CT is, (b) steps for teaching CT effectively, (c) CT well enough to teach it to young children, and (d) unplugged CT well enough to teach it. These large differences support those of past studies showing that PDPs can help teachers learn about CT (e.g., Ketelhut et al., 2020; Rich et al., 2021b). Unlike past studies of shorter PDP, this study showed that after this longer PDP, these teachers were more likely than before to view themselves as having enough knowledge of CT and CT pedagogy to teach to young children. Together, these studies indicate that PDPs can effectively help teachers learn CT knowledge and pedagogy, suggesting that educators can use effective PDPs for in-service teachers' training regarding CT knowledge.

### CT Attitudes

After these workshops, these teachers reported better attitudes toward teaching than before, especially regarding CT teaching. Specifically, they reported greater interest in CT teaching, a desire to continually find better ways to teach CT, and a desire to attend training about teaching practices. These results cohere with those of past studies showing that PDPs can improve teachers' attitudes toward CT teaching (e.g., Bower et al., 2017; Hestness et al., 2018; Rich et al., 2021b). Together, these results suggest that educators can use effective PDPs to improve teacher attitudes toward CT teaching.

### CT Beliefs

After completing these workshops, these teachers were more likely to have beliefs supporting CT teaching than before. Specifically, they were more likely to believe that (a) all students should learn CT and (b) effective teaching helps students learn CT. Unlike past studies of shorter PDPs that failed to change teachers' CT beliefs (Rich et al., 2021b), this study showed that

after this longer PDP, these teachers espoused supportive beliefs of CT teaching. If future studies replicate this result, they would suggest that educators can use effective PDPs to foster supportive teacher beliefs toward CT teaching.

### CT Teaching Self-Efficacies

After these workshops, these teachers reported greater CT teaching self-efficacies than before. Specifically, they reported greater overall CT teaching self-efficacy, plugged CT teaching self-efficacy, and unplugged CT teaching self-efficacy than before., this study showed that after this longer PDP, teachers reported greater CT teaching self-efficacies. If future studies support this result, they would suggest that educators can use effective PDPs to increase teachers' CT teaching self-efficacies.

## Explanatory Model of CT Teaching Self-Efficacies

School, workshop completion and teacher's CT knowledge were all linked to CT teaching self-efficacies. In the school with a greater sharing and teamwork culture or sufficient resources to support CT teaching, teachers reported greater overall and plugged CT teaching self-efficacies. These results suggest the importance of school culture and resources for supporting CT teaching. Also, workshop completion was linked to greater unplugged CT teaching self-efficacy. Unlike past studies of shorter PDPs (Rich et al., 2021b), this longer PDP increased teachers' unplugged CT self-efficacy. Lastly, teachers who reported greater CT knowledge reported greater overall, plugged, and unplugged CT teaching self-efficacies, cohering with past studies regarding the importance of teacher CT knowledge for CT teaching self-efficacy (Rich et al., 2021b).

### Insight Into Future PDP Design Choices

These teachers shared several insights regarding effective PDP and further needs. As many of them knew little CT, they appreciated the importance of concrete activities, educational resources, collaboration, teaching CT with unplugged activities, and enough time between workshops to apply CT. First, the concrete activities, educational resources, and collaboration helped these teachers learn an alien topic, CT. The collaborative planning helped them develop and apply CT teaching activities to their own students, especially the transitional instruction of teaching CT with unplugged activities to their students before doing so with plugged activities. Suitable spacing between workshops also enabled these teachers to apply their CT, ask for help and consolidate before the next workshop. Hence, future PDPs can consider including concrete activities, educational resources, collaboration, transitional instruction, and suitable spacing between workshops.

These teachers highlighted the need for additional support regarding time, management, resources, networking, and parents. Sufficient time allowed teachers to collaboratively learn, plan, implement and assess their newly learned CT. Furthermore, management support can provide them with such time and needed resources (technology, staff) to teach CT well. Beyond their school walls, networking with other schools teaching CT (, with researchers) and with parents can build broad community support and understanding of CT and CT instruction.

# LIMITATIONS AND FUTURE RESEARCH

Our study is limited by its small, unrepresentative, convenience sample of Hong Kong ECE teachers and its absence of a control group. The small sample limits our statistical power to detect smaller effect sizes. Furthermore, this study only included 2 schools, so we need studies with many more schools to determine whether these school differences are idiosyncratic or occur more broadly. Also, our unrepresentative sample of only ECE teachers in Hong Kong limits the potential of this study to generalize to the broader population of ECE teachers. Hence, future studies can include larger, representative samples of ECE teachers in more schools in more countries. Also, this study lacked a control group, which limits causal claims, so future studies can employ *randomized, controlled trials* to support stronger causal claims.

# CONCLUSION

This exploratory study showed that a curriculum-based professional learning professional development program changed these in-service teachers' views of computational thinking (CT). After the workshops, their CT understanding changed significantly. After completing the workshops, these teachers were more likely than before to define CT as including the algorithmic solution of a problem, analytic ability, solving problems as a computer scientist, logical problem solving, or general problem-solving. After these workshops, these teachers were more likely than before to believe that they knew (a) what CT is, (b) steps for teaching CT effectively, (c) CT well enough to teach it to young children, and (d) unplugged CT well enough to teach it.

These workshops also changed their CT beliefs, CT attitudes, and CT self-efficacies. After these workshops, these teachers reported better attitudes toward teaching than before: greater interest in CT teaching, greater desire to continually find better ways to teach CT, and greater desire to attend training about teaching practices. Compared to before these workshops, these teachers were more likely than before to have beliefs supporting CT teaching: (a) all students should learn CT and (b) effective teaching helps students learn CT. After these workshops, these teachers reported greater overall, plugged, and unplugged CT teaching self-efficacies.

School, workshop completion and teacher's CT knowledge were all linked to CT teaching self-efficacies. In the school with a greater sharing and teamwork culture or sufficient resources to support CT teaching, teachers reported greater overall and plugged CT teaching self-efficacies. Also, teachers who reported greater CT knowledge reported greater overall, plugged, and unplugged CT teaching self-efficacies.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Education University of Hong Kong. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

AS contributed to the conception and design of the study and wrote the first draft of the manuscript. MC performed the statistical analysis. Both authors organized the database, wrote sections of the manuscript, and contributed to the manuscript revision, read, and approved the submitted version.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

# APPENDIX A: ANCILLARY RESULTS

**APPENDIX TABLE A1 |** Correlations, variances, and covariances of outcomes and significant explanatory variables in the lower left, diagonal and upper right matrices.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Overall computational thinking (CT) self-efficacy | **2.91** | 2.42 | 2.57 | 1.76 | 2.53 | 0.53 | 2.62 |
| 2. Plugged CT self-efficacy | 0.89 | **2.55** | 2.55 | 1.56 | 2.22 | 0.49 | 2.19 |
| 3. Unplugged CT self-efficacy | 0.88 | 0.94 | **2.90** | 1.50 | 2.47 | 0.61 | 2.56 |
| 4. School culture of sharing and teamwork | 0.80 | 0.75 | 0.68 | **1.67** | 1.46 | 0.39 | 1.52 |
| 5. School has sufficient resources to support teaching CT | 0.86 | 0.80 | 0.83 | 0.65 | **3.02** | 0.53 | 2.72 |
| 6. After workshops | 0.63 | 0.61 | 0.72 | 0.60 | 0.62 | **0.25** | 0.55 |
| 7. Know computational thinking | 0.87 | 0.78 | 0.85 | 0.66 | 0.89 | 0.63 | **3.11** |

frontiers | Frontiers in Psychology

CURRICULUM, INSTRUCTION, AND PEDAGOGY
published: 29 June 2022
doi: 10.3389/fpsyg.2022.873044

# Teacher Becoming Curriculum Designer: Professional Teaching and Learning in China's Early Childhood Education

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The Curriculum Design Coherence Model (CDC Model) was created as a universal curriculum design method to connect disciplinary knowledge to teachers' expertise in a bid to promote professional teaching and learning. However, research into how the CDC Model has been adopted and localized in the Chinese educational context is scarce. This article focuses on the application and impact of the CDC Model on the resulting teaching practices in China's Early Childhood Education (ECE) settings. The data collected through a focus group discussion with 21 teachers from a model kindergarten at the municipal level in China reveals that the CDC Model has increased the teachers' professionalism by promoting their curriculum initiative, forging curriculum knowledge orientation, strengthening the conceptual structure within the kindergarten-developed curriculum, and enhancing the coordination between the curricula of the different courses offered by the kindergarten. This positive influence has also helped the teachers bridge their disagreement on curriculum content and pedagogy and overcome some difficulties in using the CDC Model. The study has implications for revitalizing the value of disciplinary knowledge and for viewing ECE teachers as active professional agents in ECE curriculum design and teaching.

**Keywords: Curriculum Design Coherence Model, teaching practices, China, China's Early Childhood Education, knowledge**

OPEN ACCESS

***Edited by:***
*Weipeng Yang, The Education University of Hong Kong, Hong Kong SAR, China*

***Reviewed by:***
*Pilar Rivero, University of Zaragoza, Spain*
*Richard Pountney, Sheffield Hallam University, United Kingdom*

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***Specialty section:***
*This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology*

***Received:*** *10 February 2022*
***Accepted:*** *26 May 2022*
***Published:*** *29 June 2022*

***Citation:***
*Tian X, Bao L, Li T and Gu Y (2022) Teacher Becoming Curriculum Designer: Professional Teaching and Learning in China's Early Childhood Education. Front. Psychol. 13:873044. doi: 10.3389/fpsyg.2022.873044*

## INTRODUCTION

The Curriculum Design Coherence Model (CDC Model) was first developed in 2017 to address the New Zealand curriculum context in the first instance and then started to be used in the "knowledge-enriched curriculum project" carried out in both New Zealand and the United Kingdom as a universal curriculum design method (Rata, 2019). The project was mainly committed to fulfilling four tasks. First, at the level of global curriculum ideology, in response to the prevailing 21st-century educational narratives which overemphasize generic skills, such as interpersonal communication and problem-solving strategies and thus ignore the importance of knowledge (Bolstad, 2012; Scott, 2015), this project proposed a knowledge-led approach to schooling (Rata, 2019, 2021b). Second, at the level of pedagogic practices, the project took disciplinary knowledge as the core of schooling, rather than students' subjective interests, practical needs, and future workplace expectations (McPhail, 2016). Third, at the level of evaluation, the project treated the competencies

developed based on the acquisition of disciplinary knowledge as the focus of curriculum evaluation and abandoned the modular assessment dominated by students' performance (McPhail, 2017). Fourth, in terms of curriculum effects, the project aimed to explore curriculum design that can effectively link the acquisition of disciplinary knowledge with students' cognitive architecture, thereby promoting in-depth learning and real intellectual development (Sweller et al., 2019; McPhail, 2020a).

At the very beginning of 2021, the CDC Model was introduced to a Chinese kindergarten to guide its kindergarten-based curriculum planning and teaching. Therefore, this study examines the application of the CDC Model in China's Early Childhood Education (ECE) practices and its effectiveness. The country's educational system includes five tiers, namely, ECE/Kindergartens (including six semesters contained in three academic years, ECE Year 1 to ECE Year 3), Primary School (Year 1-Year 6), Junior High School (Year 7-Year 9), Senior High School (Year 10-Year 12), and higher education. Among them, Primary School and Junior High School are compulsory. Although the ECE is not compulsory, its running is under the guidance of the unified nationally prescribed ECE policy (MoE, 2012).

We investigated the implementation of the CDC Model in China for two major reasons. First, an exploration of specialized databases such as Web of Science and Scopus finds that there is a dearth of research into the application of the CDC Model, as a novel and universal curriculum design method in China's educational context, especially in the ECE setting. Second, China is a centralized country with top-down educational policies and practices (Huang et al., 2016), thereby providing a platform to navigate how the CDC Model was localized throughout the expression, adoption, and development of the country's ECE curricula and the following teaching practices and their effects. We introduce the CDC Model first because the structure of the model provides us with both the theoretical and empirical tools to examine its application in the Chinese ECE context.

## THE CURRICULUM DESIGN COHERENCE MODEL

The CDC Model aims to promote professional teaching and learning by connecting disciplinary knowledge to teachers' expertise. By separating disciplinary knowledge from sociocultural knowledge, the CDC Model argues that the acquisition of disciplinary knowledge should be the purpose of schooling (Rata, 2019, 2021b). Following the Durkheimian tradition of the differentiation between profane and sacred knowledge, modern scholars often refer to profane knowledge as sociocultural knowledge, also variously referred to as knowledge by acquaintance, commonsense knowledge, or everyday knowledge. This type of knowledge is often tied to a specific social group's unexamined cultural beliefs, rituals, habitus, and ideological purposes which can be learned out of the classroom and in everyday life (Young, 2008; Rata, 2012; Winch, 2017).

In contrast to sociocultural knowledge which is socially constructed, disciplinary (sacred) knowledge is considered as the knowledge which has independently objective epistemic properties and which is professional, academic, rational, and powerful (Young, 2008; Rata, 2012; Beck, 2013; Vernon, 2020). Disciplinary knowledge has been created all along through human history and has been publicly scrutinized and contested over time and space so that it has its independent legitimacy and explanatory power of generalization and universalization (Rata, 2012; McPhail and Lourie, 2017). This type of knowledge is made up of abstract epistemic concepts which are immaterial and objective, with complex structures, and which are difficult to learn so they need to be taught in the classroom (Rata and Tamati, 2021). When abstract disciplinary knowledge enters the modern school disciplines and becomes contained in a school curriculum, it should be designed and altered to be concrete, visible, and available for teaching in the classroom (Rata and Tamati, 2021). This is also the aim of the CDC Model, that is, to design the abstract "conceptually integrated concepts" of the disciplinary knowledge into the concrete curriculum content for schooling (McPhail, 2020b, p. 394).

The mechanisms of incorporating disciplinary knowledge into the CDC Model are complex. To unpack the complexity and facilitate its application, the model creators dissected the model into four elements: curriculum proposition, content, competence, and evaluation (Rata, 2019, 2021b; McPhail, 2020a). The first element concerns how to design a curriculum proposition based on a given topic/theme, and how to extract key disciplinary concepts from that proposition for teaching. For example, when teaching the mathematical topic of "size," an ECE teacher may create this curriculum proposition: "size refers to the length of something, which is often described by using two words: long and short." From this proposition, the teacher may extract concepts in the discipline of mathematics such as "length," "long," and "short."

The second element shows how to embed the extracted abstract disciplinary concepts into concrete curriculum content, such as stories, texts, and videos. For example, when teaching the concepts of "long" and "short," a Mathematics teacher can draw a picture of two rulers or use two pencils with different lengths for students to compare. In this way, the teacher helps to materialize the abstract and invisible meaning of "long" and "short" into the concrete length of visible things. The materiality of immaterial disciplinary concepts often follows two criteria (Rata, 2021b). The first criterion is the *from-abstract-to-concrete* approach, referring to the sequencing of disciplinary concepts prior to the selection of curriculum content. Once the disciplinary concepts are selected, they are then sequenced per the second criterion – by following the *from-lower-to-higher-ordered-knowledge* approach (Rata, 2016). For example, an ECE teacher often teaches students lower-ordered concrete concepts such as "cat," "dog," and "sheep" before the higher-ordered abstract concept of "animal." Also, students are often taught "letter" before "word" in language acquisition and "line segment" before "geometric figure" in mathematics.

The third element demonstrates how to teach the disciplinary concepts and content through pedagogic activities that help students develop the two resulting curriculum competencies: judgment and practical competence. Judgment competence denotes the ability to understand and explain the meaning of a disciplinary concept (knowledge-what) and to use it to

explain why something is the case (knowledge-why). Practical competence refers to being able to put the acquired concept into practice (knowledge-how-to) (Rata, 2021b). *Knowing-what* and *knowing-why* lead to identifying *knowing-how-to*. In turn, *knowledge-how-to* is an illustration of *knowledge-what* and *knowledge-why* in practice (Rata, 2021b). For example, an ECE teacher often undertakes hands-on training to develop the numeracy of students by assisting them in understanding numbers (knowledge-what), differentiating a specific number from the others (knowledge-why), and using numbers to count things (knowledge-how-to).

The fourth element offers some evaluative methods to test whether students demonstrate the curriculum competencies after learning the disciplinary concepts and content. These methods include memorization (recall the meaning of a concept, knowing-what), explanation (using a concept to explain why something is the case, knowing-why), and application (putting a concept into practice, knowing-how-to). For instance, a language teacher asks students to recall the meaning of a word (memorization), to pronounce the word (application), and to tell the word from similar ones (explanation).

The conceptual structure of a discipline that is made up of disciplinary concepts provides the coherence device of the four elements of the CDC model (Muller, 2009). That is also the reason why disciplinary concepts permeate the CDC Model and link the four elements: curriculum proposition (from which a teacher extracts disciplinary concepts; the abstract and invisible meaning of curriculum knowledge), curriculum content (which materializes the disciplinary concepts; the concrete and visible content of curriculum knowledge), curriculum competencies (which demonstrate understanding and mastery of disciplinary concepts; what can be done with curriculum knowledge), and curriculum evaluation (which examines whether the disciplinary concepts were acquired, the outcomes of acquiring disciplinary concepts) (McPhail, 2020a). This also explains why this curriculum design method is named the Curriculum Design Coherence Model and why the CDC Model enables the promotion of disciplinary-knowledge-enriched teaching and learning.

## RESEARCH DESIGN

This section introduces the research design and implementation. We first introduce how the CDC Model was introduced to a Chinese kindergarten, the research participatory kindergarten, to guide its kindergarten-based curriculum planning and teaching at the beginning of 2021. The kindergarten is a role model at the municipal level and ranks among the top five kindergartens in that city. Since the outset of 2021, the top five kindergartens in the city started to design kindergarten-based curricula that integrate the city's cultural heritage and local educational resources. The curriculum practices of the five kindergartens are part of the local government's educational agenda to develop the localized ECE curricula with municipal characteristics and to popularize the curricula throughout the city in the third decade of the 21st century.

The research participatory school is one of the five kindergartens which adopted the CDC Model in planning and developing its kindergarten-based curricula. The kindergarten has a total of 26 staff, including 21 academic staff. The 21 academic staff are teachers from the five ECE areas of health, language, society, science, and art. As prescribed in the national education policy, the five areas are compulsory in China's ECE settings (MoE, 2012). Following the national policy, the kindergarten offers seven courses that embed the five areas (see **Table 1**). We provide detailed information about the 21 teachers as they played the main role in attending the training on the CDC Model, in developing the kindergarten-based curricula under the guidance of the CDC Model, and in using the CDC Model in their teaching practices. Therefore, they are also the main research participants of the study.

In 2021, the kindergarten conducted a total of six sessions of teacher training on the CDC Model, one session every 2 months. The duration of each session varied from 2 to 3 h. Of the six sessions, the first two focused on introducing the CDC Model and exemplifying its applications with specific curriculum design cases. The last four sessions were around the application of the CDC Model. The 21 teachers were invited to share their curriculum design cases which demonstrated the use of the CDC Model, followed by discussions of any comments, suggestions, and questions raised in the process.

Immediately following each training session, the kindergarten organized the 21 teachers to put the CDC Model into the kindergarten-developed curricula practices. Upon our empirical investigation, we found that the teachers had accomplished four tasks with the CDC Model as a guide. First, they determined the disciplinary concepts for the curriculum of each course contained in the 3-year kindergarten program, sequenced them following the from-concrete-to-specific order and from-lower-to-higher-ordered-knowledge approach, and allocated them into the specific courses used in the six respective semesters of the three

**TABLE 1 |** The participants.

| ECE area prescribed in the national policy | Courses offered by the kindergarten | Number of teachers | Average years of work experience | Academic degree |
|---|---|---|---|---|
| Health | Physical Education and Health | 4 | 3.5 | All bachelors |
| Language | Chinese and English | 5 | 4 | All bachelors |
| Society | Story | 3 | 2 | All bachelors |
| Science | Mathematics | 5 | 4 | 4 Bachelors and 1 master |
| Art | Music and Fine Art | 4 | 3 | All bachelors |

academic years. Second, they configured specific curriculum content for the sequenced disciplinary concepts. Third, they formulated new standards of curriculum evaluation for teachers and students. Finally, they organized a teaching competition around the kindergarten-developed curricula, exploring effective ways to put the curricula into practice.

The study was conducted after the six training sessions and the teachers' completion of the foregoing four curriculum-related tasks. As mentioned above, the 21 teachers all participated in planning the kindergarten-based curricula as major designers, developers, and implementors. To have them all involved in the research, upon having received the research ethics approval, and with their consent, we conducted a semi-structured focus group discussion with them to investigate the impact of the CDC Model on their curriculum designing and the following teaching practices. This method proved to be effective in researching the impact of the CDC Model on the 21 teachers' teaching practices. In particular, this method helps us to observe the participants talking about the same topic from multiple perspectives and to collect data about their interactive dis/agreements or corrections that cannot be obtained from individual interviews (Hennink, 2014).

In this study, the focus group discussion started with a structured session for the review of the CDC Model. Then the opportunity was passed to the floor for the teachers to conduct a collective face-to-face discussion about the impact of the CDC Model on their teaching practices, lasting approximately 2 h. Given that running a focus group with 21 participants was very difficult to do, the participants were first divided into seven small groups according to the courses they were teaching at the moment, with some semi-structured questions (such as "What difficulties have you encountered in applying the CDC Model?," "How do you overcome the difficulties?," "In what ways have the CDC Model contributed to or hindered your teaching practices?") provided for them to stimulate their discussion. After that, one teacher from each of the seven groups was invited to share the opinions on behalf of the group members. When all the viewpoints were collected from the seven groups, the 21 teachers were organized to conduct a free discussion on some of the opinions such as "What should be the starting point of the kindergarten-developed curricula: students' experiences and life-worlds or teachers' professional knowledge and understanding or others?," "What is the most creative part in the use of the CDC Model?"

All the conversations were in Chinese to avoid any possible ambiguities or misunderstandings and at the same time to enable the participants to share more in-depth views by using their mother tongue. Furthermore, conducting the discussion in Chinese allowed us, as Chinese researchers, to "take advantage of [our] linguistic ability and cultural awareness" in the investigation (Sit, 2012, p. 32). We made digital audio recordings of the discussion and then transcribed them verbatim for substantial analysis (Nowell et al., 2017). The empirical study aims to answer the research question: To what extent and in what ways has the CDC Model exerted an influence on the ECE teachers' teaching practices? The next section reports on the research findings, with data collected from the 21 teachers merged to protect their identity.

# RESEARCH FINDINGS

The research finds the CDC Model has influenced the teaching practices of the 21 teachers mainly through (i) promoting their initiative for curriculum designing, (ii) forging the curriculum knowledge orientation, (iii) strengthening the conceptual structure of the kindergarten-developed curricula, and (iv) enhancing the coordination among the curricula of the seven courses provided by the kindergarten.

## Promotion of Initiative for Curriculum Designing and Teaching

Professional teaching and learning require teachers to take the initiative in designing and teaching curricula (Gao, 1998). However, the focus group discussion reveals that the teachers' curriculum designing and teaching initiative was suppressed for a long time. Prior to the kindergarten-developed curricula, the teachers were asked to use the nationally prescribed curricula and teaching materials. Curriculum development was regarded as a highly specialized task of the experts because its creation, implementation, and evaluation were monopolized by them to a great extent. As practitioners, the 21 teachers merely played a supporting role in the implementation of the prescribed curricula. Under such conditions, resistance or even hostility toward mandated education may be generated from the teachers because the "true teacher voice" was repressed (Kragler et al., 2008, p. 547).

The long-term passive curriculum implementation also to some extent led to the loss of the teachers' curriculum initiative. The group discussion shows that the majority of them abandoned the unique and innovative ideas for curriculum design and teaching that they had had at the outset of their careers as ECE teachers, and went back to the official curricula because they were judged as having deviated from the prescribed curriculum content and evaluation methods. In addition, the official curricula provided them with ready-made materials such as pedagogic plans, goals, preparations, procedures, processes, tips, and textbooks. In the discussion, many of them expressed that they had become substantively dependent on the national curricula and the easy-to-get supporting curriculum resources, losing their initiative in designing curriculum.

Being deprived of the curriculum initiative for a long time, the teachers felt like *fish out of water* at the start when they were assigned the task to develop the kindergarten-based curricula. This task stagnated at the outset because the teachers did not have a solid knowledge foundation in curriculum design (most of them had only a bachelor's degree) and thus lacked professional knowledge of curriculum development. In addition, they obtained little professional training on curriculum planning. As a result, the task returned the right of curriculum development to the teachers, but it brought them huge psychological and professional challenges and pressures.

Fortunately, the training on the CDC Model reduced this pressure and promoted their initiative in curriculum development. They expressed in the group discussion that the CDC Model had guided them in designing the

kindergarten-based curricula, which changed their role from mere curriculum users to curriculum designers and executors. This increase in curriculum initiative further stimulated their pedagogical agency to make critical reflections on the curricula used for the seven courses offered by the kindergarten. For example, some music teachers in the discussion mentioned that they had incorporated the disciplinary concept of "noise" into the Music Curriculum. For them, the distinction between music and noise should have been the very first lesson contained in the course. This also demonstrates the growth of their professionalism because one indispensable characteristic of teachers' professional development lies in their ability to make critical reflections (Lehrer, 2013).

The CDC Model also contributed to the improvement of the teachers' pedagogy by enhancing the professional cooperation among them, which further promoted their initiative in curriculum implementation. According to the teachers, the kindergarten organized a pedagogic competition called *One Lesson, Three Classes* for teaching the kindergarten-developed curricula. In the competition, every three teachers were invited to design and teach the same lesson contained in the curricula they had jointly designed and the other teachers were asked to join the lesson as commentators. After each lesson, the teacher commentators would evaluate the lesson, the pedagogic strategies, activities, and design. The lesson lecturer was asked to do a self-reflection on the lesson. The CDC Model was adapted to offer the criteria for the evaluation and self-reflection.

According to the teachers, the competition improved their teaching initiative. For now, when designing a lesson, the majority of them have become used to asking themselves a series of independent and critical questions, such as, what disciplinary concept does the lesson address? What content is used to teach the concept? Is the content familiar to students? Can the content help students understand the concept and develop corresponding curriculum competencies? The growing responsibility for curriculum implementation and their desire to provide quality lessons to students indicated the growth of the teachers' pedagogical leadership and initiative in curriculum designing and teaching (Heikka et al., 2016; Ukkonen-Mikkola and Fonsén, 2018; Fonsén and Ukkonen-Mikkola, 2019). Moreover, the CDC Model enhanced the professional cooperation and communication between the teachers, and these collaborative works are supportive of teachers' professional development (Cherrington and Thornton, 2013; Cotton, 2013).

## Orientation Toward Curriculum Knowledge

The CDC Model helps to eliminate the differences between the teachers and promotes an orientation toward disciplinary knowledge in their teaching practices. This is the case because the definition of curriculum teaching is often vague in the ECE context (Kangas et al., 2021). The group discussion showed that disputes had existed between the teachers over planning the content and pedagogy of the kindergarten-based curricula before the training on the CDC Model.

Some teachers believed that the kindergarten-developed curricula should proceed from students' experiences and life-worlds. They argued that teaching should be student-centered. For them, the ECE classrooms in the past were too much around the official curricula and the pursuit of the prescribed skills, neglecting students' learning interests. Therefore, they argued that the kindergarten-developed curricula should not address substantive literate or numeracy skills, but enable students to have a basic understanding of symbols, to attract their learning interest, and to allow them to study in a more relaxed environment – that is enough.

However, other teachers thought that the kindergarten-developed curricula should be established on the teachers' professional knowledge, rather than the interests of students. For them, only when the teachers design and implement the curricula with their professional understanding and experience of the students can they truly guide the students to learn the curricula. As for pedagogy, they held no brief for a student-led teaching approach which, according to them, often overestimates students' cognitive ability, life experience, and social skills. A lesson called *The Little Sheep is Angry* for year-two students was mentioned as an example by a teacher in the discussion to demonstrate the disadvantages of a student-led pedagogy. The teacher used a student-led pedagogy by inviting the students to listen to the story, analyzing the causes and consequences of the little sheep's anger, and then answering the question: "How can the sheep relieve its anger?" The teacher constantly guided the students to answer the question without bringing up any of his ideas. In the discussion, the other teachers who audited the class rated it to be not successful because year-two students were too young to express their limited views in complete and coherent words and thus were not suited for a student-centered pedagogy.

The CDC Model settled the teachers' differences in curriculum design and pedagogy. According to the discussion, they now spontaneously agree that neither students' life-worlds nor teachers' professional understanding of students should be the curriculum basis, but it should be disciplinary knowledge. In addition, professional teaching should center on neither teachers nor students, but on the competencies developed based on the acquisition of curriculum knowledge. For example, following the CDC Model, the aforementioned teacher improved his lesson design. The teacher still adopted a student-led pedagogy but he brought three pictures of a sheep listening to music, a sheep doing housework, and a sheep running in the park, into the lesson as hints to guide the students to come up with their solutions to anger. The teacher became much clearer that the lesson aimed to teach the students the disciplinary concept of "anger" and to develop their competencies to overcome being angry. This increase in the teachers' pedagogical competence suggested how the CDC Model had empowered them as professional designers and agents of both curriculum and pedagogy (Fonsén and Ukkonen-Mikkola, 2019).

## Strengthening the Conceptual Structure of the Curricula

The application of the CDC Model attributes to strengthening the conceptual structure of the kindergarten-based curricula used

for the seven courses in the kindergarten. That is, the CDC Model has helped the teachers to establish the kindergarten-developed curricula by following the *from-the-concrete-to-abstract* order and the *from-lower-to-higher-ordered-knowledge* structure mentioned above. For example, the mathematics teachers interviewed mentioned in the group discussion that, when making the Mathematics Curriculum for teaching the concept of "geometric figure," the curriculum focused on teaching the figures of circles, squares, and triangles to ECE year-one students by aligning these figures with real objects such as car tires, floor tiles, and kites. The curriculum for ECE year-two students was about knowing the more complex figures of rectangles, ellipses, trapezoids, and rhombus by mastering their basic and unique characteristics such as corners and sides. The curriculum for ECE year-three students highlighted cultivating students' competence to draw the foregoing figures by the descriptions of their characteristics.

The teachers believed the disciplinary concept of "geometric figures" helped to achieve the conceptual structure of the Mathematics Curriculum used in the three academic years. The CDC Model takes the *from-the-concrete-to-abstract* order and *from-lower-to-higher-ordered-knowledge* approach in curriculum concept sequence and progression. Therefore, the teachers had considered and designed the multimodalities of the disciplinary concept of "geometric figure" by linking it to students' cognitive characteristics of processing mathematical concepts. To be specific, and according to the discussion, 3- or 4-year-old students (ECE Year One) have a weaker perception of geometric figures, and their eyes can only focus on the interior rather than the outline of a figure, therefore they cannot accurately identify the figure. Because of this, the curriculum was determined to align simple figures with real objects to establish students' geometric awareness. However, students around the age of five (ECE Year Two) have better perception ability and begin to notice the typical parts of a figure. Therefore, the curriculum for year-two students focused on recognizing more complex figures *via* their unique characteristics. For year-three students (around the age of six), their perception ability is further developed, which allows them to form a cognitive pattern that can control the direction and range of their eye movements along the outline of a figure as if making a typical model of the figure in their mind for recognition of it. Therefore, the curriculum was designed for students to draw a figure by the descriptions of its characteristics. The discussion indicated that it was the CDC Model that had guided the teachers to strengthen the conceptual structure of the kindergarten-developed curricula.

## Enhancement of the Coordination Between Different Curricula

The group discussion also indicated that the CDC Model facilitated and enhanced the coordination among the kindergarten-developed curricula. We use the term "coordination" to refer to the linkage of the same disciplinary concept contained in the curricula of the seven different courses. According to the discussion, curriculum coordination was a collective intellectual invention that came from the teachers' discussions and reflections.

In the group discussion, the teachers mentioned the teaching of the concept "cat," which may be a good example to explain what is curriculum coordination as theorized by us. While developing the kindergarten-based curricula, they had arranged the teaching sequence and assigned different focuses in each of the curricula of the seven different courses offered by the kindergarten to teach the concept. To be specific, to teach the concept of "cat," the Fine Art Curriculum focuses on using pictures to guide students in understanding the meaning of "cat" first. Then, the Chinese and English Curricula focus on reading and writing the word "cat." After that, the Mathematics Curriculum develops students' numeracy ability by using questions like "How many cats are there in the picture?" and cultivates students' geometric ability *via* guiding students to draw a cat using shapes like circles, triangles, and rectangles. The Story Curriculum highlights the characteristics and personality of cats by using fables. The Music Curriculum embeds the "miaow" sound of the cat into lyrics for students to sing. The Physical Education and Health Curriculum incorporates the learning of the cat into games called "cat chases mouse."

According to the teachers, the coordination between the curricula used for the parallel courses offered by the kindergarten not only provided them with the means to touch the five academic areas of health, language, society, science, and art prescribed in the national ECE policy (MoE, 2012) but also strengthened their sensitivity to curriculum resources available around them. This also witnessed the value of quality teacher education in enhancing the professional competencies of teachers (Ukkonen-Mikkola and Fonsén, 2018; Fonsén and Ukkonen-Mikkola, 2019).

# DISCUSSION AND CONCLUSION

In this section, we conclude the article by discussing the inherent relationship between the CDC Model, its implementation, and the outcomes as observed in the empirical study. We find that the relationship is embedded in how the CDC Model has contributed to the three independent traits of teachers' professionalism in curriculum designing and teaching as theorized by Gao (1998). Therefore, we forged our discussion around the three traits.

The first trait addresses the professionalism that is built upon professional knowledge and theories. The CDC Model was created based on curriculum theories (Rata, 2019, 2021b; McPhail, 2020a). The training on the CDC Model, its four elements, and the linkage between them enriched the teachers' knowledge bank on curriculum design which in turn increased their professionalism in designing the kindergarten-based curricula. As a consequence, the task to develop the curricula offered a solid epistemological basis for them to practice their knowledge and skills in curriculum design, which further fostered their professionalism. As noted by Fonsén and Ukkonen-Mikkola (2019), "The benefits of continuous professional learning enhance reliance and support the motivation to gain further professional knowledge"

(p. 185). The opportunities which allow the teachers to link their professional knowledge to their teaching practices also constitute one "core [feature] that [characterizes] effective professional development" of ECE teachers (Zaslow et al., 2010, p. ix).

This also reflects why an increasing number of studies call for greater attention to be paid to ECE teachers' professional development by addressing the important role of teacher knowledge and content-rich pedagogy (e.g., Cervetti et al., 2012; Neuman and Kaefer, 2018; Neuman and Danielson, 2020). For example, Breffni (2011) suggests that professional curriculum training has proven to be effective in facilitating and improving prekindergarten teachers' knowledge and practices in the United States. McLachlan et al. (2017) find that by engaging with professional development programs that address teacher knowledge and skills, teachers' curriculum practices can be improved effectively in New Zealand.

The second trait suggests that professionalism often has a unique function to perform. The CDC Model performed its unique function of assisting teachers in understanding the importance of disciplinary concepts and forging their teaching practices toward curriculum knowledge. The discussion revealed that the teachers agreed that there should be a disciplinary concept behind their teaching practices. As they exemplified in the discussion, teaching students how to perform on a balance beam can help them understand the concept of "balance." This also resonates with Chan et al.'s (2009) research where the teachers used waste as materials and dolphins as symbols to teach children the disciplinary concepts of "recycling" and "harmony."

The teachers' re-identification and recognition of the central role of disciplinary knowledge in their teaching practices *via* the training and utilization of the CDC Model may also help them teach disciplinary knowledge, which Young (2008) calls *powerful knowledge*. This is because teachers' interest and motivation in adjusting their teaching practices were stimulated and increased once they presented high fidelity to the curriculum and its underpinning philosophy (Lieber et al., 2009). In addition, a clear understanding of the educational core and decision-making process in the teaching practices is also essential for teachers to serve children and their families, especially in the contemporary period (Gordon et al., 2016).

The third trait denotes that professionalism is not subject to the control of external forces and is reliable for teachers to make autonomous professional judgments. The CDC Model helped the teachers make independent decisions in their teaching practices. The foregoing coordination between the kindergarten-developed curricula of the seven courses, as the collaborative creation of the teachers, is a good example to illustrate this. The teachers also expressed their growth in making professional judgments by overcoming independently the two major difficulties that they encountered in the application of the CDC Model.

The first difficulty was how to design a good curriculum proposition. According to the CDC Model, the design departure is a given topic; a curriculum proposition is designed based on the given topic; disciplinary concepts, usually more than one, are extracted from the curriculum proposition; curriculum content is designed to teach the concepts (McPhail, 2020a). To this end, the purpose of designing a curriculum proposition is to teach multiple disciplinary concepts contained in one lesson. However, the lessons contained in the kindergarten-based curricula were not that complex and each lesson usually touched on only one disciplinary concept. To this end, there is no need to design a proposition and then extract only one knowledge concept from it for teaching. In their practices, the teachers changed the curriculum design departure from topics to disciplinary concepts. They first examined the history, major debates, and *status quo* of a discipline to sort out the concepts that students need to know about the discipline, and then materialized the concepts into appropriate and specific content and topics. This avoids the procedure of making curriculum propositions, thus overcoming the first difficulty. Their practices proved this solution was useful.

According to the teachers, determining the concepts first before the content also offered them ways to overcome the second difficulty in using the CDC Model: the curriculum concept and content were sophisticatedly intertwined, sometimes making it difficult to distinguish one from the other. By selecting concepts and sequencing them before preparing the content, the teachers can ascertain that the curriculum concepts follow a *from-lower-to-higher-ordered-knowledge* sequence that promotes students' conceptual progression (Rata, 2016). In this way, even if sometimes the content and concepts were intertwined, the internal disciplinary structure of the curriculum knowledge remains unchanged.

To conclude, the CDC Model enables the teachers to become the curriculum designers, in Moss's (2008) words, "democratic and reflective professionals" in curriculum development (p. 125) by promoting their curriculum initiative, forging curriculum knowledge orientation, strengthening the conceptual structure of the kindergarten-developed curricula, and enhancing the coordination between parallel curricula. This positive influence also helped them bridge the disagreement on curriculum content and pedagogy and overcome some difficulties in using the CDC Model independently.

It is important to treat curriculum design and implementation as educational practices to do *with* ECE teachers, rather than *to* them, and to make them the active agents in curriculum-based endeavors (Cherrington and Thornton, 2013; Baker, 2017). The study shows the value of the CDC Model and the model-based curriculum practices in helping teachers overcome the traditional trainer-directed teacher training with limited follow-up on learning practices that thus reduces the training effectiveness (Karagiorgi et al., 2008). The study also has implications for conducting continuous and regular further professional training for ECE teachers because they "deserve the highest quality professional learning to support the implementation of new instructional materials and curriculum" (Short and Hirsh, 2020, p. 2). Most importantly, the study has implications for revitalizing the value of disciplinary knowledge in teaching and learning that has relevance to a broad international audience of ECE agents, including policymakers, teachers, stakeholders, practitioners, researchers, and parents (Rata, 2021a).

## DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of School of Humanities and Foreign Languages, Xi'an University of Posts and Telecommunications. Written informed consent to participate in this study was provided by the participants.

## AUTHOR CONTRIBUTIONS

XT, LB, and TL contributed to the conception and design of the study, conducted the data analysis, and wrote the first draft of the manuscript. YG organized the database and validated the data analysis. All authors contributed the to manuscript revision, read, and approved the submitted version.

## FUNDING

This research leading to these results has received funding from the Humanity and Social Science Research Program (Grant No. NY219008) granted by Nanjing University of Posts and Telecommunications.

## ACKNOWLEDGMENTS

We thank the creators of the Curriculum Design Coherence Model, Elizabeth Rata, and Graham McPhail from the University of Auckland, New Zealand.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers | Frontiers in Psychology

ORIGINAL RESEARCH
published: 22 July 2022
doi: 10.3389/fpsyg.2022.909842

# Adaptation and Validation of a Scale for Measuring the Curriculum-Based Professional Learning Community in Early Childhood Education in China

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**Specialty section:**
*This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology*

**Received:** *31 March 2022*
**Accepted:** *17 June 2022*
**Published:** *22 July 2022*

**Citation:**
*Peng Q, Liu L, Zhang L and Yue Y (2022) Adaptation and Validation of a Scale for Measuring the Curriculum-Based Professional Learning Community in Early Childhood Education in China. Front. Psychol. 13:909842. doi: 10.3389/fpsyg.2022.909842*

Teachers' professional learning community, as an effective path to promote teachers' professional development and elevate teaching quality, has been widely used in school contexts. In preschools, the practice of teachers' professional learning community mainly focuses on the curriculum in early childhood education. The revision and adaptation of the scale of the professional learning community for preschool teachers in the Chinese cultural context are of great significance for understanding the current situation of the professional learning community for preschool teachers and improving the quality of collaboration within the community. Teachers' Professional Learning Community scale was revised into the Curriculum-Based Professional Learning Community scale according to the characteristics of the curriculum in early childhood education in the Chinese context. Based on the data from a sample of 2,823 teachers, the study conducted an item analysis and exploratory factor analysis (EFA) on participants from sample A ($N$ = 1,410) and confirmatory factor analyses (CFAs) on participants from sample B ($N$ = 1, 413). Short-form Teacher Self-Efficacy scale was used as the criteria-related validity instrument. Sample A and sample B were used to explore the relationship between various dimensions of teachers' professional learning community and teachers' teaching efficacy. The results showed that instead of the five-factor structure of the original PLC scale, the Chinese version of the CBPLC scale consists of four factors: Shared Sense of Purpose, Collective Focus on Children Learning and Development, Collaborative and Reflective Activity, and Deprivatized Practice. The revised scale has high reliability and validity and can be used as an effective tool to measure the curriculum-based professional learning community of preschool teachers in China. The results of CFA indicated that the four-factor CFA model fit the data well, and the CBPLC significantly and positively predicted teachers' self-efficacy including instructional strategies, students' engagement, and classroom management.

**Keywords: teacher's self-efficacy, early childhood education, Chinese context, curriculum-based professional learning community, model testing**

## INTRODUCTION

Recently, adult learning is more and more viewed as a process of full participation in communities of practice that requires situated learning or on-the-job training (Lave and Wenger, 1991). Over the past decades, "work-based learning" has become a focal issue in the field of research on teacher professionalization (Tynjälä, 2013). The way of teachers' professional development has changed from a top-down perspective with the assumption that teachers are lacking the sufficient skills and knowledge and need to be educated by external experts, to a bottom-up perspective which is teacher-driven, purposeful for teaching practice, and directed toward improving student learning (Bergmark, 2020). Numerous studies in teacher education believe that teacher-centered collaborative learning can bring both teachers' professional development and students' achievement growth (Chong and Kong, 2012; Akiba and Liang, 2016; Moy et al., 2021). Collaborative learning can afford an opportunity for teachers to establish wellconnected networks through which they share and rethink their educational practice and pedagogical beliefs, as a result co-construct knowledge through social interaction (Chan and Pang, 2006).

Professional learning communities (PLCs) have been seen as an important tool to enhance teachers' collaborative learning. The literature on PLCs shows that PLCs can facilitate teacher development (Stoll et al., 2006; Huijboom et al., 2021), improving teachers' knowledge and classroom practice (Andrews and Lewis, 2007) and students' achievement (Buysse et al., 2010; Bergmark, 2020; Wasik and Hindman, 2020). The construction of PLCs has become a centerpiece of many proposals for restructuring schools and supporting teachers' classroom practice and professional development (Newmann and Wehlage, 1995; Louis et al., 1996; Louis and Marks, 1998; Garet et al., 2001). As for preschool teachers, PLCs can promote preschool teachers' teaching experience, improving teachers' ability of critical thinking and reflection, expanding the overall experience of individual teachers, and maintaining a harmonious interpersonal relationship on the campus through constantly instructional problem-centered communication with colleagues (Liu, 2018). Further, with the increasingly complex roles of preschool teachers, it is necessary to improve teachers' professional development through PLCs. Although the positives of PLCs are often discussed, there is limited information about preschool teachers' experiences in a PLC (Damjanovic and Blank, 2021).

With the development of PLCs, the curriculum-based professional learning community (CBPLC) has received increasing attention recently. Darling-Hammond et al. (2017) pointed out that effective teachers' professional development should focus on curriculum and classroom. Voogt et al. (2011) concluded that the practice of collaborative curriculum design can facilitate teacher learning processes. CBPLC guides a series of focused, small-group sessions, cooperative learning, peer cooperation, and reflective teaching discussion to solve curriculum and instruction problems, allowing teachers to teach according to the needs of the students. Teachers' subject knowledge and pedagogical content knowledge (PCK) can be developed in CBPLC through rehearsing lessons and focusing on common concerns (Polly et al., 2016; Short and Hirsh, 2020). CBPLC can close the gap between adult's views and child's perspectives, challenging teachers' beliefs, overcoming teachers' teaching obstacles, and enhancing their teaching confidence and teaching satisfaction (Polly et al., 2016; Darling-Hammond et al., 2017; Short and Hirsh, 2020; You et al., 2021).

Research on PLCs in the ECE context is rare but growing. And it has been encouraged to conduct more PLC research in the Chinese cultural contexts (Hairon et al., 2017; Yin et al., 2019). Since the "new curriculum reform" launched in 2001, curriculum decentralization has made preschool-based curriculum development as the basic tendency of curriculum reform in early childhood education in China, which means higher requirements for the professionalization of preschool teachers. Therefore, the professional standards for preschool teachers (Trial) issued by the Ministry of Education of China in 2012 proposed that preschool teachers should "have the spirit of teamwork, actively carry out cooperation and communication, learn together, constantly reflect and forge ahead… . Cooperate and exchange with colleagues, share experience and resources and develop together." PLCs have become a basic way to promote the construction of teams of preschool teachers and the improvement in instruction quality. Some Chinese scholars refer to the teaching and research groups (TRGs), lesson preparation groups, and research groups of schools in the stage of basic education in China as PLCs or potential PLCs (Sargent and Hannum, 2009; Qiao et al., 2018).

Researchers from European and American countries have designed scales to measure PLCs (Louis and Marks, 1998; Olivier et al., 2009). Due to cultural differences, PLCs in Chinese preschools are different from those in the Western. Therefore, PLCs measurement tools derived from Western situations are not necessarily suitable for the Chinese context. We hope to revise the measurement tools of CBPLC suitable for Chinese preschools. Studies have identified a positive relationship between teachers' self-efficacy and teachers' participation in a PLC (Stegall, 2011; Porter, 2014). CBPLC may increase the possibility of this kind of relationship with teachers' self-efficacy. The study chose the relationship between CBPLC and teacher self-efficacy for model testing.

### Teachers' Professional Learning Community

The notion of PLCs proposed by DuFour and Eaker (2009) refers to a group of organized teachers sharing and reflecting their practice and beliefs in a collaborative, collegial, practice-oriented, and, teaching- and learning-oriented, teacher-oriented way to enhance teachers' professional development (Hord, 1997; Stoll and Louis, 2007; Darling-Hammond et al., 2009). As teachers collaborate with colleagues on effective instructional practices in the work-embedded context, with the help of experts outside, PLCs became renowned as the solution to teachers' personalized learning and struggling alone, and a valid means for realizing collaborative decision making, improving teachers' satisfaction, and facilitating students' achievement (DuFour and Eaker, 2009; Hord and Sommers, 2009). Of course, it is necessary to make

a distinction between the romanticized notion of PLCs and the facts which exist in PLCs' practice with tension at times, competition, and even a lack of enthusiasm in participating (Damjanovic and Blank, 2021).

Different researchers seem to ascribe different characteristics to a PLC, and recently, people began to realize that the form of PLC does not necessarily bring ideal results and high-quality PLC needs conditions to support. The description of PLCs' features presents two research paradigms. One paradigm focuses on describing the characteristics of the operational process of PLCs such as collaboration, reflection, and giving and receiving feedback (Louis et al., 1996; Huijboom et al., 2021). The other paradigm focuses on the conditions required for a well-functioning PLC such as supportive and shared leadership (Hord, 1997; Hord and Sommers, 2009), deprivatization of practice, and its results such as collective learning and shared values (Hord, 1997; Louis and Marks, 1998; Hord and Sommers, 2009). Alongside these characteristics, professional learning integrated in the daily practices of specific social communities is also highlighted (Tynjälä, 2013).

## The Teacher Professional Learning Community Scale

Professional Learning Community Assessment (PLCA) was used to assess everyday classroom and school-level practices according to the conceptualization of the PLC dimensions and related attributes (Huffman and Hipp, 2003) which is revised as Professional Learning Community Assessment—Revised (PLCA-R), which include six factors: shared and supportive leadership, shared values and vision; collective learning and application; shared personal practice; supportive conditions—relationships; and supportive conditions—structures. It can be seen that the scale from Louis and Marks (1998) has always occupied the mainstream. Based on the hypothesis that a schoolwide professional community defined as an element of school organizational culture can help teachers become "better teachers," Louis and Marks (1998) investigated the relationship between a PLC and classroom organization and, subsequently, student learning. A five-factor model is proposed by Louis et al. (1996) and Louis and Marks (1998), which includes five components: shared value, collective focus on student learning, collaborative activity, reflective dialogue, and deprivatized practice. Fundamental to the school professional learning community are shared values and expectations which teachers affirm about children, instruction, teachers' roles, the relationship between teachers and students, and so on. A collective focus on student learning is central to the school professional community by leading teachers to provide appropriate teaching and learning opportunities to promote students' development. To improve their skills for effective instruction, teachers share expertise through collaborative professional development activities such as peer coaching, teamed teaching, structured classroom observations, and reflective dialogue about teaching and learning in the professional community, which increases teachers' sense of affiliation with each other and with the school. This conceptualization that emphasizes collaboration and organizational supporting for teacher learning has been validated in the Chinese context (Yin and Zheng, 2018; Huang et al., 2020).

## Professional Learning Communities (PLCs) as Learning Environments for Teachers

As an example of a PD model, PLCs may create a supportive learning environment for the teacher through a reflective, collaborative, and teacher-centered approach nested in teachers' everyday experiences in the classroom. However, PLCs are also such an environment as teachers' engagement in the PLC around the social construct through identification and negotiability. Whether PLCs are seen as a worthwhile endeavor as a viable means of professional development depends on whether the PLC can bring teachers a sense of belonging (Damjanovic and Blank, 2021) and is work-embedded (Darling-Hammond et al., 2017; Damjanovic and Blank, 2021). Ideal PLCs should incorporate elements of effective professional development by providing chances for active, collaborative, and reflective learning for teachers, focusing on students' learning and supporting student achievement in the end (Darling-Hammond et al., 2017).

Strong professional communities have a positive effect on the job satisfaction of preschool teachers because PLCs create mutual learning chances for them, allowing them to share responsibility for students, permitting them to develop the best strategy for teaching through social interaction, and designing, implementing, and improving curriculum with collective efforts (Stearns et al., 2014). According to Huijboom et al. (2021), the concept of PLCs is a joint learning of individual and collective learning and creating collective knowledge. Important conditions that PLCs facilitate teachers' professional development include the followings: opportunity to collaborative learning, support from school leaders and experts, authorized collective autonomy, time, space and sources, teachers' teaching needs met, and organizing reflective instruction (Darling-Hammond et al., 2017; Huijboom et al., 2021).

## CBPLC and Preschool Teachers' Professional Development

Based on the theoretical framework of social learning, studies emphasized a professional development process based on collaboration, specific situations, and job-embedded model (Penuel et al., 2007; Bergmark, 2020; Short and Hirsh, 2020). Effective teachers' professional development should provide teachers coaching and other supports to cater to teachers' needs (Zhang et al., 2019, 2020), facilitating teachers' problem-based involving-in-learning (Short and Hirsh, 2020). PLCs allow teachers to combine professional development skills and knowledge for instructional planning, diagnosis of student learning, and action research for re-teaching (DuFour et al., 2008). The integrated nature of curriculum, assessment, and instruction is the most important and fundamental factors in effective teaching (Marzano, 2003; Roach et al., 2008). Recently, significant efforts to develop high-quality curriculum materials are aligned with educational reform and teachers' professional development (Penuel et al., 2007). The reason for this is that the Utopia of reform will not be transformed into daily

classroom practice without the marriage of a new curriculum and teacher learning (Ball and Cohen, 1996). PLCs have been proved to be an effective way to empower teachers (Stoll et al., 2006; Huijboom et al., 2021). In particular, curriculum-based professional learning placed the focus on a curriculum which rooted in teachers' ongoing, active experiences and allowed teachers to experience instruction as their students will. That stands in contrast to traditional teacher training, which typically relays a static mass of information that teachers selectively apply to existing practice. The research showed that curriculum-based professional learning can prompt teachers to change their instructional practices, expand their content knowledge, and challenge their beliefs (Polly et al., 2016). Among curriculum-based professional learning, the Lesson Study approach developed the preschool teachers' content knowledge as they designed, taught, and reflected upon early number of lessons (Leavy and Hourigan, 2017). Compared with traditional teachers' professional development, CBPLC calls for several major shifts: focuses on the curriculum goals to promote teacher professional learning with instructional materials with specific teaching strategies, grinders class collectively instead of fighting alone, possesses a lot of opportunities for curriculum-focused coaching, reflecting and feedback, experiences inquiry-based learning, and models the sense-making strategies teachers will apply to students (Short and Hirsh, 2020).

CBPLC can change teachers' beliefs in their teaching and young children's learning, such as adopting learner-centered pedagogy, improving teachers' PCK and practice ability, and improving young children's achievement finally (Polly et al., 2013, 2016; Wasik and Hindman, 2020).

## Professional Learning Community and Teachers' Self-Efficacy

In the past few decades, the study of self-efficacy from the perspective of cognition or social cognition has become a hot spot. Teachers' self-efficacy (TSE), theoretically coming from the concept of self-efficacy, is defined as the confidence teachers hold about their capabilities in a specific teaching situation to bring about expected teaching outcomes (Bandura, 1982; Tschannen-Moran et al., 1998; Klassen et al., 2011; Locke and Johnston, 2016). According to Locke and Johnston (2016), teacher self-efficacy has developed into a two-dimensional construct: the self-perception of teaching competence and the sense of task difficulty. The measurement of TSE is mainly from the following three dimensions: Efficacy for Instructional Strategies (TSE-IS), Efficacy for Classroom Management (TSE-CM), and Efficacy for Student Engagement (TSE-SE) (Tschannen-Moran and Hoy, 2001).

PLCs increase teachers' self-efficacy (Reeves, 2010), and several researchers attributed the improvement in teachers' self-efficacy to the cooperative attribute and the continuous improvement in PLCs (Porter, 2014; Zonoubi et al., 2017). Cooperations in PLCs create opportunities for teachers to experience sharing, discussion on effective teaching strategies, and acceptance of suggestions and feedback from experts and their colleagues (Wahlstrom and Louis, 2008; Zonoubi et al., 2017). The model of continuous improvement existing in PLCs not only improves teachers' pedagogical knowledge and teaching ability, but also facilitates teachers' self-efficacy (Zonoubi et al., 2017). The four sources of efficacy information mentioned by Bandura (1997) also conceptually support the proposition that PLCs serve as a space for the development of teachers' self-efficacy (Zonoubi et al., 2017). Several pieces of research show that learning opportunities teachers consider available in the working situation have a significant positive prediction on teachers' self-efficacy (Lakshmanan et al., 2011; Stegall, 2011; Porter, 2014).

## The Current Study

The current academic community has reached a basic consensus on the definition and characteristics of PLC, and the practice of PLC has been studied using both quantitative and qualitative research methods. Improving teachers' instructional practices plays a key role in the improvement in early childhood education and the healthy physical and mental development of young children (Keung et al., 2020). However, research on PLCs in the Chinese context has focused on the primary and secondary school levels, with less research on the current state of PLCs in preschools. In addition to this, there is a lack of measurement of teacher PLCs that has been tested for good reliability and validity based on the context of early childhood education.

Specifically, the two objectives of this study are as follows:

1. To explore issues related to the measurement of CBPLCs and to revise the original scale to adapt to the Chinese cultural context for early childhood education.
2. To verify the model proposed in this study by exploring the relationship between CBPLCs and preschool teachers' self-efficacy.

# METHODS

## Stage 1: Revising the Chinese Version of the Curriculum-Based Professional Learning Community Scale

### Participants

Based on the characteristics of the Chinese kindergarten management structure, a snowball approach was used to collect the questionnaires. The researcher forwarded the web link of the questionnaire to the principals of kindergartens across China, who in turn distributed it to their kindergarten teachers for completion.

The total number of questionnaires returned was 2,947, of which 2,823 were valid, with an effective rate of 95% (2,823/2,947). Participants were arbitrarily divided into two subsamples utilizing the random split function in SPSS V26. Sample A ($N = 1{,}410$) was used for conducting EFA in stage 1, and sample B ($N = 1{,}413$) was used to test factor structure and concurrent validity in stage 2. The demographic information distribution of the respondents of sample A and sample B is given in **Table 1**. To confirm that sample A and sample B have the same validity in the next data analysis procedure, we use the chi-square difference test to examine whether the two samples were

**TABLE 1 |** Demographics of participants ($N = 2,823$).

| Demographic characteristic | Code in SPSS | Sample A ($N = 1,410$) | | Sample B ($N = 1,413$) | |
|---|---|---|---|---|---|
| | | *N* | % | *N* | % |
| **Gender** | | | | | |
| Female | 1 | 1,391 | 98.7 | 1,397 | 98.9% |
| Male | 2 | 19 | 1.3 | 16 | 1.1% |
| **Age** | | | | | |
| <22 | 1 | 273 | 19.4 | 262 | 18.5 |
| 23–25 | 2 | 289 | 20.5 | 314 | 22.2 |
| 26–30 | 3 | 271 | 19.2 | 268 | 19.0 |
| 31–35 | 4 | 237 | 16.8 | 247 | 17.5 |
| 36–40 | 5 | 176 | 12.5 | 165 | 11.7 |
| >40 | 6 | 164 | 11.6 | 157 | 11.1 |
| **Professional Title** | | | | | |
| No title | 1 | 1,004 | 71.2 | 1,015 | 71.8 |
| Third title | 2 | 88 | 6.2 | 95 | 6.7 |
| Second title | 3 | 207 | 14.7 | 198 | 14.0 |
| First title | 4 | 101 | 7.2 | 91 | 6.4 |
| Senior title | 5 | 10 | 0.7 | 14 | 1.0 |
| **Position** | | | | | |
| Assistant teacher | 1 | 601 | 42.6 | 622 | 41.9 |
| Head teacher | 2 | 524 | 37.1 | 501 | 33.7 |
| Grade/teaching and research group leader | 3 | 178 | 12.6 | 184 | 12.3 |
| Administrative positions such as deputy director | 4 | 118 | 8.3 | 115 | 7.8 |
| Other position | 5 | 64 | 4.5 | 63 | 4.2 |
| ***Bianzhi* (budgeted post)** | | | | | |
| Owned | 1 | 82 | 5.8 | 97 | 6.9 |
| Non-owned | 2 | 1,328 | 94.2 | 1,316 | 93.1 |
| **Residence of preschool** | | | | | |
| City | 1 | 746 | 52.9 | 759 | 53.7 |
| Township | 2 | 551 | 39.1 | 530 | 37.5 |
| Rural | 3 | 113 | 8.0 | 124 | 8.8 |
| **Types of preschool** | | | | | |
| Public | 1 | 643 | 45.6 | 661 | 46.8 |
| Private inclusiveness | 2 | 560 | 39.7 | 547 | 38.7 |
| Private | 3 | 207 | 14.7 | 205 | 14.5 |

significantly different in these demographic characteristics. The chi-square difference results showed that there was no significant difference between sample A and sample B in terms of gender, age, professional title, position, budgeted post, the residence of preschool, and types of preschool (all $p$ values $> 0.05$; gender [$x^2_{(1)} = 0.04$, $p = 0.84$]; age [$x^2_{(5)} = 2.09$, $p = 0.83$]; professional title [$x^2_{(4)} = 1.84$, $p = 0.76$]; position [$x^2_{(5)} = 6.32$, $p = 0.27$]; budgeted post [$x^2_{(4)} = 4.225$, $p = 0.37$]; residence of preschool [$x^2_{(2)} = 1.01$, $p = 0.60$]; types of preschool [$x^2_{(2)} = 0.38$, $p = 0.82$]).

## Measure

This study translated the Professional Learning Community scale developed by Louis and Marks (1998) and revised it in order to fit the context of early childhood education and the characteristics of the "curriculum in early childhood education." The original PLC scale is an English questionnaire that has been applied in a Chinese context (Yin et al., 2019). First, the original scale was translated into Chinese by a master's student in preschool education and a PhD student with 3 years of overseas study experience and was revised according to the actual situation of the early childhood curriculum.

Second, an associate professor of English education was invited to back-translate the scale from Chinese to English. Comparing the different parts of the two English translations, revise them and then translate them into Chinese, we analyzed and evaluated the two Chinese translations, and 10 preschool in-service teachers working in preschools were invited to put forward suggestions on revising the ambiguous sentences in the scale or those inconsistent with Chinese expression habits.

Finally, with the approval of the revised scale by two associate professors and senior experts who have been engaged in early childhood education research for many years, a Chinese version of the Curriculum-Based Professional Learning Community (CBPLC) scale was formed.

The original scale consists of five dimensions: Shared Sense of Purpose (3 items), Collaborative Activity (6 items), Focus on Student Learning (4 items), Deprivatized Practice (4 items), and Reflective Dialogue (2 items). Item 7, "I make a conscious effort to coordinate the content of my courses with other teachers" in the "CA" dimension, does not correspond to the actual situation of the preschools in the Chinese context. Therefore, we remove this item and replace it with "Teachers plan and work together to search for measures to meet diverse student needs."

### Data Analytic Strategy

A series of exploratory factor analyses (principal component analysis) were performed using IBM SPSS V26 to explore the latent structure of the CBPLC scale which is adapted from the original PLC scale.

## Stage 2: Confirmatory Factor Analysis and Validity of the CBPLC Scale

### Participants

Sample B ($N$ = 1,413) was utilized for the CFA and to supply initial evidence of validity by testing anticipated relationships with theoretically similar constructs (teacher self-efficacy).

### Measures

#### *Demographic Questionnaire*

In the demographic questionnaire, basic information about the teachers was collected, including teachers' age, gender, position, professional title, *bianzhi* (budgeted post), types of preschools, and residence of preschools.

#### *Curriculum-Based Professional Learning Community*

We measured the curriculum-based professional learning community using the 19-item scale validated in stage 1. The original scale consists of five subscales: shared sense of purpose, collective focus on student learning, collaborative activity, deprivatized practice, and reflective dialogue. Cronbach's alpha was 0.972. Each item was appraised on a six-point Likert-type scale, extending from 1 = *strongly disagree* to 6 = *strongly agree*.

#### *Teacher Self-Efficacy*

The teacher self-efficacy scale (12 items, TSE-short), which was developed by Tschannen-Moran and Hoy (2001), was used in this study. The scale consists of three dimensions: efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement. Each item was appraised on a six-point Likert-type scale, extending from 1 = *strongly disagree* to 6 = *strongly agree*. Teacher self-efficacy was reported to be significantly associated with teacher professional community (Zheng et al., 2018b). Tschannen-Moran and Hoy (2001) provided high reliability estimates, higher than 0.90. Zheng et al. (2018a) reported that the reliability of the Chinese version of the scale was estimated to be higher than 0.86. In our research, Cronbach's alpha was 0.95.

### Data Analytic Strategy

To examine the construct validity of the CBPLC scale, we first conducted confirmatory factor analysis (CFA) using maximum likelihood estimations to access the model fit which was run to test five models to choose the best structure of CBPLC. Model fit indices $\chi^2$, $\chi^2/df$ ratio, Tucker–Lewis index (TLI), comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA) are used to access the goodness of fit of the models. According to Hu and Bentler (1999), when the model fit index is $\chi^2$ ($p < 0.05$), $\chi^2/df \leq 3$, CFI $\geq 0.90$, TLI $\geq 0.90$, and RMSEA and SRMR $< 0.80$, the model is considered to be a good fit. In addition to this, we used a chi-square difference test to rule out the possibility that the five models were not significantly different from each other. Mplus 8.0 was used for data analysis.

# RESULTS

## Exploratory Factor Analysis (Sample A)

Sample A ($N$ = 1,410) was used for EFA. Before conducting exploratory factor analysis, we utilized the Kaiser–Meyer–Olkin test and Bartlett's test to prove the appropriateness of the collected data for factor analysis. The Kaiser–Meyer–Olkin measure of sample adequacy was 0.974, whereas the Bartlett's test of sphericity was significant ($p < 0.001$), showing that the data were suitable for an EFA, as suggested by Tabachnick et al. (2007).

Based on the factor analysis using varimax rotation, after limiting the number of extracted factors, we obtained four structures, including a two-factor structure, a three-factor structure, a four-factor structure, and a five-factor structure.

In the two-factor structure, factor 1 consisted of 16 items (eigenvalue = 13.225, variance explained = 69.607%) and factor 2 consisted of 3 items (eigenvalue = 5.856, variance explained = 75.472%).

In the three-factor structure, factor 1 consisted of 14 items (eigenvalue = 13.225, variance explained = 69.607%), factor 2 consisted of 3 items (eigenvalue = 5.856, variance explained = 75.472%), and factor 3 consisted of 2 items (eigenvalue = 0.644, variance explained = 78.859%).

In the four-factor structure, factor 1 consisted of 9 items (eigenvalue = 13.225, variance explained = 69.607%), factor 2 consisted of 5 items (eigenvalue = 5.856, variance explained = 75.472%), factor 3 consisted of 3 items (eigenvalue =0.644, variance explained = 78.859%), and factor 4 consisted of 2 items (eigenvalue = 0.514, variance explained = 81.565%).

In the five-factor structure, factor 1 consisted of 8 items (eigenvalue = 13.225, variance explained = 69.607%), factor 2 consisted of 5 items (eigenvalue = 5.856, variance explained = 75.472%), factor 3 consisted of 3 items (eigenvalue = 0.644, variance explained = 78.859%), factor 4 consisted of 2 items (eigenvalue = 0.514, variance explained = 81.565%), and factor 5 consisted of 1 item (eigenvalue = 0.417, variance explained = 83.578%). In this structure, the last factor consists of only one item. As suggested, we removed the five-factor structure.

**TABLE 2 |** Results of the exploratory factor analysis on the CBPLC in sample A ($N = 1,410$).

| Items | Factor loading | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Two-factor | | Three-factor | | | Four-factor | | | |
| | F1 | F2 | F1 | F2 | F3 | F1 | F2 | F3 | F4 |
| CBPLC1 | | 0.670 | | 0.552 | | | | 0.829 | |
| CBPLC2 | | 0.851 | | | 0.835 | | | 0.881 | |
| CBPLC3 | | 0.891 | | | 0.886 | | | 0.531 | |
| CBPLC4 | 0.674 | | 0.684 | | | 0.704 | | | |
| CBPLC5 | 0.566 | | 0.707 | | | 0.677 | | | |
| CBPLC6 | 0.802 | | 0.714 | | | 0.549 | | | |
| CBPLC7 | 0.812 | | 0.711 | | | 0.704 | | | |
| CBPLC8 | 0.827 | | 0.746 | | | 0.691 | | | |
| CBPLC9 | 0.794 | | 0.733 | | | | 0.667 | | |
| CBPLC10 | 0.821 | | 0.727 | | | | 0.681 | | |
| CBPLC11 | 0.815 | | | 0.747 | | | | | 0.785 |
| CBPLC12 | 0.822 | | | 0.775 | | | | | 0.712 |
| CBPLC13 | 0.805 | | 0.734 | | | | 0.599 | | |
| CBPLC14 | 0.664 | | 0.640 | | | 0.746 | | | |
| CBPLC15 | 0.815 | | 0.816 | | | | 0.754 | | |
| CBPLC16 | 0.828 | | 0.842 | | | | 0.795 | | |
| CBPLC17 | 0.840 | | 0.827 | | | 0.717 | | | |
| CBPLC18 | 0.774 | | 0.731 | | | 0.730 | | | |
| CBPLC19 | 0.812 | | 0.758 | | | 0.714 | | | |
| Eigenvalues | 13.225 | 5.856 | | | 0.644 | | | | 0.514 |
| % of variance explained | 69.607% | 75.472% | | | 78.859% | | | | 81.565% |

**Table 2** shows the clustering of factor loads for each item and the correlation between each factor and the corresponding factor. According to Comrey and Lee (2013), a factor load greater than 0.4 was used to consider the variable as significant.

## Confirmatory Factor Analysis (Sample B)

We conducted a series of CFAs for sample B ($N = 1,413$). Five models were tested and compared.

*Model 1: One-factor model. All items of the CBPLC loaded on a single latent factor (a unidimensional one-factor model).*
*Model 2: Two-factor model. The model structure is derived from EFA.*
*Model 3: Three-factor model. The model structure is derived from EFA.*
*Model 4: Four-factor model. The model structure is derived from EFA.*
*Model 5: Five-factor model. The model structure is derived from the original study by Louis and Marks (1998).*

**Table 3** shows the fit indices and results of chi-square difference test of each model, and it can be seen that model 4 has a better fit than the other models.

### One-Factor Model

This model has a poor fit and can be considered unsuitable to be adopted as the structure of CBPLC ($\chi^2/df = 22.711$, CFI = 0.885, TLI = 0.871, SRMR = 0.033, and RMSEA = 0.17).

### Two-Factor Model

Most of the fit indices of this model are considered to be of an acceptable degree, but the value of RMSEA is on the high side ($\chi^2/df = 17.616$, CFI = 0.913, TLI = 0.901, SRMR = 0.027, and RMSEA = 0.108). The two-factor model exhibited a better fit than the one-factor model, as reflected by a significant chi-square difference ($\Delta\chi^2 = 791.98$, $p < 0.001$).

### Three-Factor Model

This model has a better fit than the two-factor model, but there are still some unsatisfactory fit indices ($\chi^2/df = 14.663$, CFI = 0.929, TLI = 0.919, SRMR = 0.018, and RMSEA = 0.098). The three-factor model exhibited a better fit than the two-factor model, as reflected by a significant chi-square difference ($\Delta\chi^2 = 475.25$, $p < 0.001$).

### Four-Factor Model

The fit indices of this model are the best among all models, and all reach the desired interval ($\chi^2/df = 11.773$, CFI = 0.945, TLI = 0.936, SRMR = 0.020, and RMSEA = 0.080). The four-factor model exhibited a better fit than the three-factor model, as reflected by a significant chi-square difference ($\Delta\chi^2 = 465.96$, $p < 0.001$).

### Five-Factor Model

The dimensions of this model are divided according to the dimensions of the original PLC scale. However, the model fit

**TABLE 3 |** Confirmatory factor analyses in sample B ($N = 1,413$).

| Model | $\chi^2$ | *df* | $\chi^2/df$ | SRMR | TLI | CFI | RMSEA | Comparison | $\chi^2$ diff test |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3,452.028 | 152 | 22.711 | 0.033 | 0.871 | 0.885 | 0.124 | – | |
| 2 | 2,660.040 | 151 | 17.616 | 0.027 | 0.901 | 0.913 | 0.108 | 2 vs 1 | 791.98(<0.001) |
| 3 | 2,184.790 | 149 | 14.663 | 0.018 | 0.919 | 0.929 | 0.098 | 3 vs 2 | 475.25(<0.001) |
| 4 | 1,718.827 | 146 | 11.773 | 0.020 | 0.936 | 0.945 | 0.080 | 4 vs 3 | 465.96(<0.001) |
| 5 | 2,353.112 | 142 | 16.571 | 0.027 | 0.908 | 0.923 | 0.105 | 5 vs 1 | 1,098.9(<0.001) |

*Model 1, one-factor model; model 2, two-factor model; model 3, three-factor model; model 4, four-factor model; model 5, five-factor model. N = 1,413; $\chi^2$ = chi-square statistic; CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual; $\chi^2$Diff test, chi-square difference test, ANOVA test.*

results showed that the model fit index of this model was poor and did not apply to the adapted CBPLC scale ($\chi^2/df = 16.571$, CFI = 0.923, TLI = 0.908, SRMR = 0.027, and RMSEA = 0.105). This model is a nested model of model 1 and has a significant chi-square difference from model 1 ($\Delta\chi^2 = 1098.9$, $p < 0.001$).

## Concurrent Validity (Sample B)

This step evaluates the concurrent validity of the CBPLC by examining its correlation with teacher self-efficacy. Teacher self-efficacy was measured by 12 items developed by Tschannen-Moran and Hoy (2001). The Chinese version of this scale has been validated in China (Cheung, 2008; Liu and Hallinger, 2018). The correlations between each dimension of CBPLC and teacher self-efficacy were examined. **Table 4** reports the results of the correlation coefficients of the study variables. As expected, CBPLC was found to be positively associated with teacher self-efficacy (r = [0.299,0.890], $p < 0.001$). It was found that the correlation between the CRA and DP dimensions was high ($\beta = 0.89$) and the possibility of variable covariance needed to be excluded. We used the tolerance statistic and the variance inflation factor (VIF) to demonstrate the absence of multicollinearity among the four dimensions. In statistics, it is generally accepted that tolerance values less than 0.1 point to the presence of multicollinearity and VIF values greater than 10 indicate multicollinearity. After calculation, the value of each dimensional tolerance is greater than 0.1 and the value of VIF is less than 10. There was no evidence of multicollinearity in this study. The results of the test are given in **Table 5**. PLCs were generally able to positively influence teacher self-efficacy, with the amount of explanation for both reaching extremely significant levels.

Second, the author constructed a SEM of the relationship between the four elements of CBPLC and teacher self-efficacy. The results of the model are shown in **Figure 1**. The model has a good fit ($\chi^2 = 3567.88$, $df = 413$, $p < 0.001$, RMSEA = 0.052, CFI = 0.965, TLI = 0.96). The graph only shows the paths that reached the significant level ($p < 0.05$). As shown in **Figure 1**, the four elements of CBPLC explained the three dimensions of teaching efficacy ($R^2$) at a significant level ($p < 0.01$). Specifically, DP positively predicted all three dimensions of teacher self-efficacy across the four dimensions of professional community, and CFCLD had a significant positive effect on teaching strategy efficacy ($\beta = 0.18$, $p < 0.01$). Notably, SSOP had no effect on teaching efficacy in the model, while CRA had a negative and significant effect on teachers' classroom management efficacy ($\beta = -0.13$, $p < 0.01$).

# DISCUSSION

The research described in this article aims to revise and validate the Curriculum-Based Professional Learning Community (CBPLC) scale as a measurement tool in the Chinese ECE context. This is the first measurement tool that integrates the kindergarten curriculum with a professional learning community for teachers.

In stage 1, the original PLC scale was translated by using the classic back-translation method. An item that did not correspond to the actual situation of kindergartens was deleted, and an item related to the collaborative activity of teachers was added.

The EFA tested in stage 1 showed that the dimensions of the revised scale had some adjustments from the original scale. This is because the original scale was administered to teachers from primary and secondary schools, and the form of professional learning community for these groups differs significantly from that of preschool teachers. The nature of the ECE context would seem to be conducive to collaborative practices because teachers usually work in the same physical space and interact frequently throughout the whole working day (Thornton and Cherrington, 2018).

The CFA was conducted to confirm which structure of the CBPLC obtained from stage 1 has the best model fit. Five models were examined in stage 2: a one-factor model, a two-factor model, a three-factor model, a four-factor model, and a five-factor model. The four constructs model was the best fit for the data.

The first dimension of the CBPLC scale contains nine items (items 4, 5, 6, 7, 8, 14, 17, 18, and 19) which include all the items from the Collaborative Activity and Reflective Dialogue dimensions of the original PLC scale. These two dimensions describe the learning, reflective, and dialogic activities that preschool teachers engage in collectively. Therefore, the first dimension of the CBPLC scale was named "Collaborative and Reflective Activity." The second dimension of the CBPLC scale consisted of five items (items 9, 10, 13, 15, and 16). Most of the questions in this dimension were derived from the "Deprivatized Practice" dimension of the original scale, so the naming of this dimension remains unchanged. The third dimension of the

**TABLE 4 |** Correlation coefficients of CBPLC with teacher self-efficacy ($N = 1,413$).

| | TSE-IS | TSE-CM | TSE-SE | CRA | DP | SSOP | CFCLD | CBPLC | TSE |
|---|---|---|---|---|---|---|---|---|---|
| TSE-IS | 1 | | | | | | | | |
| TSE-CM | 0.736*** | 1 | | | | | | | |
| TSE-SE | 0.745*** | 0.825*** | 1 | | | | | | |
| CRA | 0.485*** | 0.404*** | 0.441*** | 1 | | | | | |
| DP | 0.498*** | 0.432*** | 0.469*** | 0.890*** | 1 | | | | |
| SSOP | 0.368*** | 0.299*** | 0.325*** | 0.714*** | 0.643*** | 1 | | | |
| CFCLD | 0.423*** | 0.352*** | 0.383*** | 0.774*** | 0.710*** | 0.674*** | 1 | | |
| CBPLC | 0.501*** | 0.421*** | 0.458*** | 0.975*** | 0.930*** | 0.810*** | 0.833*** | 1 | |
| TSE | 0.896*** | 0.930*** | 0.932*** | 0.481*** | 0.506*** | 0.358*** | 0.419*** | 0.499*** | 1 |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. *TSE-IS, efficacy for instructional strategies; TSE-CM, efficacy for classroom management. TSE-SE, efficacy for student engagement; CRA, Collaborative and Reflective Activity; DP, Deprivatized Practice; SSOP, Shared Sense of Purpose; CFCLD, Collective Focus on Children Learning and Development. *, ** statistical table.*

CBPLC consists of three items (items 1, 2, and 3). This dimension is exactly the same as the "Shared Sense of Purpose" dimension of the original scale, so the naming of this dimension remains unchanged. The fourth dimension of the CBPLC scale contains two items (items 11 and 12). These two items come from the "Collective Focus on Student Learning" in the original PLC scale, so the name of this dimension remains unchanged. In summary, the four dimensions of CBPLC are as follows: (a) Collaborative and Reflective Activity (CRA), 9 items; (b) Deprivatized Practice (DP), 5 items; (c) Shared Sense of Purpose (SSOP), 3 items; and (d) Collective Focus on Children Learning and Development (CFCLD), 2 items.

Why does CBPLC in ECE in China present a four-factor model instead of a five-factor model? This may be due to the different cultures and practice in the preschool's PLCs between China and Western countries. In China, due to the cultural orientation of collectivism, preschools' PLCs tend to integrate such factors as cooperating in curriculum construction and collective teaching research through collective reflection and dialogue mainly to improve the whole teaching quality. Therefore, in practice, it shows the integration of collaborative activity, reflective dialogue, and shared practice of the original table. China's Ministry of Education issued Several Opinions on Improving and Strengthening Teaching Research in 2001, calling for the establishment of a "school-based teaching research system." In February 2012, China's Ministry of Education issued the professional standards for preschool teachers (Trial), which further emphasized that preschools should carry out preschool-based research and promote teachers' professional development (Ministry of Education of the People's Republic of China, 2012). Preschool-based teaching research for all teachers mainly takes collective teaching research, such as lesson study, class listening and evaluation, collective lesson preparation, and topic discussion. With the decentralization of curriculum power and the strengthening of the curriculum leadership consciousness of the principle of preschool, the construction of preschool-based curriculum and class-based curriculum has become an important content of preschool-based teaching research. Preschool-based teaching research makes comprehensive use of individual reflection and collective reflection, with a focal point of collective reflection, that is, through collective teaching research and with the help of individual reflection to promote collective reflection, to solve some common problems of preschool teachers and promote the improvement in the overall curriculum and teaching quality of preschools. Demand-oriented and problem-centered approach has become the current popular trend of PLCs in China's preschools, that is, the community emphasizes teaching research activities based on preschool teachers and children's development and needs to solve problems. This is true for rural public preschools, especially for urban preschools.

**TABLE 5 |** Tolerance and variance inflation factor of CBPLC four dimensions.

| Variance | Tolerance | Variance inflation factor (VIF) |
|---|---|---|
| CRA | 0.159 | 6.300 |
| DP | 0.210 | 4.759 |
| SSOP | 0.462 | 2.164 |
| CFCLD | 0.366 | 2.735 |

The results show that the interpretation amount ($R^2$) of the four elements of CBPLC on the three dimensions of teacher self-efficacy reached a significant level ($p < 0.01$) and there was an extremely significant positive correlation between CBPLC and all dimensions of teacher self-efficacy. PLCs increase teachers' self-efficacy (Reeves, 2010) because of their collaborative nature (Porter, 2014) and reflective nature, school collective atmosphere (Meristo and Eisenschmidt, 2014; Aldridge and Fraser, 2015). Teachers attributed teacher self-efficacy growth to the characteristics of the PLCs as described above just because they provide activities such as collaborative discussions, peer observations, improving teachers' knowledge and skills for teaching, classroom management, and teacher–student interaction (Zonoubi et al., 2017). The above interpretation also applies to China.

Among the four dimensions of PLCs, DP significantly and positively predicts the three dimensions of TSE. According to the scale this study is revising, DP describes that preschool teachers participate in teaching research activities regularly with the help of preschool principals, scholars outside and peers

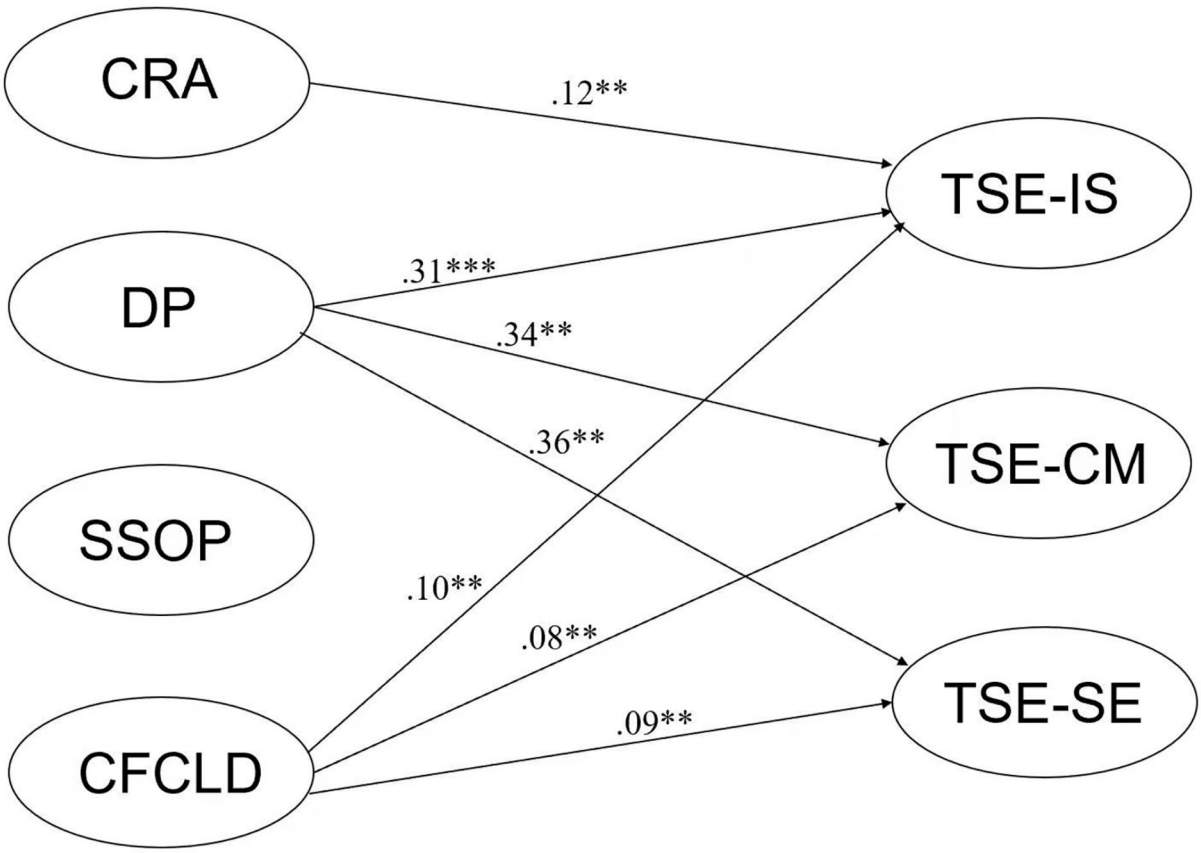


**FIGURE 1 |** SEM of CBPLC and TSE. ***$p < 0.001$, **$p < 0.01$. TSE-IS, efficacy for instructional strategies; TSE-CM, efficacy for classroom management. TSE-SE, efficacy for student engagement; CRA, collaborative and reflective activity; DP, deprivatized practice; SSOP, shared sense of purpose; CFCLD, collective focus on children learning and development.

through listening to and evaluating lessons each other, and reviewing and discussing children's activities and performance in class collectively. PLCs in early childhood education in China are the cluster professional orientation which includes shared mental models, contributing to the effectiveness of PLCs (Huijboom et al., 2021). DP improves teachers' collaboration in case of well-connected teacher social networks and teachers' self-efficacy as a result (Slavit et al., 2011; Voelkel, 2011; Moolenaar et al., 2012).

The reason why Collective Focus on Children Learning and Development (CFCLD) positively predicts teachers' three dimensions of self-efficacy is that CFCLD means that teachers always pay attention to children's learning and development, especially in the pedagogy and curriculum, rather than a certain achievement or performance as the activity result. The guiding outline for early childhood education (Trial) issued in 2001 puts forward educational concepts such as lifelong learning, happy childhood life, and respect for children's personality and rights. Since the Ministry of Education issued the Guide for the Learning and Development of Children Aged 3–6 in October 2012, early childhood education research and training institutions across the country have been actively studying, interpreting, and implementing it. Teachers' learning in the PLC focuses on teaching strategies, class management, teacher–student interaction, and students' participating in learning. As a result, teachers' knowledge, ability, and belief in student learning are improved, which enhances teachers' self-efficacy.

Collaborative and Reflective Activity (CRA) only significantly predicts teachers' efficacy of instructional strategy (IE), which has no relationship with the other two dimensions of teacher self-efficacy. The reasons lay in CRA focusing on teachers' joint commitment to the curriculum construction of preschools and teachers' teaching. And the content of teachers' collective learning does not involve or rarely involves specific matters such as class management and students' involvement.

In the model, SSOP (shared sense of purpose) does not affect teachers' self-efficacy. This conclusion is not completely consistent with the research conclusion of Zheng et al. (2018a). Zheng et al. (2018a) believes that in terms of the research sample, the shared sense of purpose has a significant positive impact on TSE-IS and TSE-SE. Of course, the establishment condition of these relationships is that teachers have a high sense of identity with the value of the school and the planning objectives of the school (short-term and long-term objectives), and the development vision and curriculum concept of the school is formed after the joint discussion of teachers. The fact is that the popular authoritarian management mode makes the development vision and curriculum concept and cooperation of Chinese Preschools more top-down as

shown in a recent empirical study of teachers in East Asia (Chen et al., 2018).

## CONCLUSION

Revising and adapting the scale of preschool teachers' professional learning community to the Chinese cultural context is important for understanding the current situation of preschool teachers' professional learning community and improving the quality of cooperation within the community. This study first used the back-translation method to translate the PLC scale and adapted it to the curriculum context in early childhood education, resulting in the CBPLC scale. The four-factor model of the CBPLC scale was validated as the most appropriate structure based on the analysis of the data returned from a large-scale questionnaire. The four factors were named as (1) Shared Sense of Purpose, (2) Collective Focus on Children Learning and Development, (3) Collaborative and Reflective Activity, and (4) Deprivatized Practice. Finally, the relationship that CBPLCs can positively predict teacher self-efficacy was also validated.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary files, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

QP drafted the manuscript. LZ designed the research and revised the manuscript. LL and YY collected and extracted the data for analysis. All authors have approved the final version of this article.

## FUNDING

This work was supported by the Project of Humanities and Social Sciences of Ministry of Education of the People's Republic of China [21YJC880092].

## ACKNOWLEDGMENTS

The authors are grateful to all teachers participating in the study for their strong support.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 30 September 2022
DOI 10.3389/fpsyg.2022.1006184



OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

RECEIVED 29 July 2022
ACCEPTED 13 September 2022
PUBLISHED 30 September 2022

CITATION
Zhang L, Wu T, Liu L, Ren P and Lin C (2022) The relationship between Chinese preschool principal leadership styles and teacher leadership: Exploring the mediating effect of psychological capital.
*Front. Psychol.* 13:1006184.
doi: 10.3389/fpsyg.2022.1006184



# The relationship between Chinese preschool principal leadership styles and teacher leadership: Exploring the mediating effect of psychological capital

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Enhancing teacher leadership is not only one of the approaches to improving teaching and learning, but it is also essential to the success of education reform. Based on leader-member exchange theory, 294 preschool teachers in China were surveyed, and a structural equation model was established to explore the relationship between the participating teachers' principal leadership style, teacher leadership and psychological capital. The findings revealed a significant positive correlation between transformational and transactional leadership styles and preschool teacher leadership. The laissez-faire leadership style had no correlation with preschool teacher leadership. The transformational leadership style and transactional leadership style were significantly and positively correlated with psychological capital, while the laissez-faire leadership style was significantly and negatively correlated with psychological capital. The transformational leadership style can positively influence preschool teacher leadership directly and indirectly through psychological capital; and the transactional leadership style can only positively influence preschool teacher leadership indirectly through the mediating role of psychological capital. Preschool teachers' leadership can neither be directly influenced by a laissez-faire leadership style nor be indirectly influenced through the mediating role of psychological capital.

KEYWORDS

**early childhood education, principal leadership styles, teacher leadership, psychological capital, teacher education**

## Introduction

Since the 1980's, with the emergence of educational reform worldwide, many countries have started to recognize the cultivation and enhancement of teacher leadership as a way to achieve successful educational reform. Teacher leadership has become a key factor in driving change in schools. Scholars have come to realize that the model of relying solely on the school's top leader, the preschool principal, to promote school development is not working as well as expected (Harris and Muijs, 2005). The traditional concept of one-person leadership by the preschool principal has been replaced by a new concept of leadership that recognizes the potential of shared leadership by teachers within the school (Marks and Printy, 2003; Katzenmeyer and Moller, 2009). Moreover, in preschool, the individual leadership of the preschool principal is not sufficient to meet the various developmental needs of the school and the children. Every teacher or member of the organization in the preschool has the authority and responsibility to demonstrate their leadership (Bellibaş et al., 2020). Educational reform can be acted upon successfully only when teachers act (Beachum and Dentith, 2004).

Teacher leadership practices, in other words, involve teachers in decision-making within the school. The scope of this decision-making is not limited to a particular classroom, but covers nine school-wide areas: instructional co-ordination, curriculum development, staff development, evaluation, general school improvement, personnel, rules and discipline, general administration and policymaking (Duke et al., 1980). In these areas, the role of teachers in the decision-making of early childhood curriculum is very important, as curriculum is the core of early childhood education and successful leadership (Yang, 2019). Similarly, teachers are also an important factor in the development of early childhood curriculum (Yu, 2007). The *Basic Education Curriculum Reform Outline (Trial)* issued by China's Ministry of Education in 2001 states that preschool teachers should make practical work plans and implement them flexibly according to the practical situation of the children in the class. During the transformation phase of the curriculum, each local preschool has its own characteristics, and each teacher and child in each school is different. Preschool teachers, as implementers of the early childhood curriculum, are in a better position to develop and implement appropriate curricula because they are more aware of the physical and psychological characteristics of their own children and their curriculum practices (Wei and Cheng, 2022). At the same time, this requires teachers to shift from their previous role as curriculum implementers, to give full play to their leadership in curriculum development, to flexibly adjust and optimize the curriculum based on children's authentic feedback, and to build a truly child-centered curriculum.

## Teacher leadership

Harris and Muijs (2005) defined teacher leadership as the ability of a community of teacher learners to contribute and influence others to improve educational practices. York-Barr and Duke (2004) defined teacher leadership as the process through which teachers influence members of the school community to improve their teaching and learning. Enhancing teacher leadership not only supports the embedding of educational reform but also promotes the process of teachers' professional learning and development (Taylor et al., 2011). Through collaborative leadership, early childhood education professionals can lead the reform of pedagogy that shapes and improves their professional practice (Hallet, 2013). In an atmosphere where "teacher leadership" is emphasized and promoted, there will be greater collaboration between teachers, a greater desire for teachers to have a voice in the improvement of teaching and learning, and a more proactive focus on improving and changing teaching practice. In the professional learning community, teacher professional development is supported through peer observation, team teaching and reflective dialogue (Chow, 2016). As long as teachers have the appropriate support, they can lead innovation, build professional knowledge, and develop their leadership capacity and influence and practice in their schools (Frost, 2012). The cultivation and improvement of teacher leadership can change the traditional role positioning and understanding of teachers in a timely manner and make teachers realize that they can also be nonpower "leaders" with a positive influence on others.

## Principal leadership style

It is obvious that the improvement of teacher leadership requires the unremitting efforts of individual teachers, but it will also be affected by other factors. Peer relationships are a key factor affecting teacher leadership (Margolis, 2012; Fairman and Mackenzie, 2015). High trust and positive working relationships among peers and with administrators can increase teachers' willingness to support other teachers in cooperation (Silva et al., 2000). In addition, preschool principals have played an important role in influencing the development of teacher leadership, including whether preschool principals have a clear understanding of the role of leaders, whether they have accepted the existence of teacher leaders and recognized the value of their presence rather than a threat, and whether they have encouraged good teachers to become leaders (Buckner and McDowelle, 2000). The overly authoritarian or permissive leadership styles of preschool principals are not conducive to the development of teacher leadership (Thornton, 2010). Highly supportive preschool principals express their expectations of improving teaching to teacher leaders in repeated communication and regard teacher leaders as useful teaching resources. They

also support the development of teacher leaders by adopting strategies such as "expecting teachers to communicate with teacher leaders" in communication (Mangin, 2007).

Influenced by a hierarchical management structure, the management system of preschool in China is led by the preschool principal, which means the preschool principal is responsible for dealing with the mission of the school, the training plan and the appointment of teachers and other major issues and decisions (Jiang et al., 2016). The preschool principals actually have full leadership over the preschool. In the process of managing the preschool and creating organizational culture, the preschool principals' own leadership behavior will affect the psychological state and working state of teachers. For example, preschool principals influence teachers' job satisfaction and leadership through their authority degree of openness (Wang and Xia, 2020). The process by which the principal delegates and discloses his or her authority to the preschool teachers is essentially the principal's adoption of an open and inclusive leadership style to enhance the leadership of the preschool teachers.

According to *full-range leadership theory* (FRLT), the latest paradigm in leadership style theory, there are three types of leadership styles: transformational, transactional, and laissez-faire. These three leadership styles basically cover the main aspects of modern leadership styles (Avolio and Bass, 2001).

Burns (1978), based on Maslow's hierarchical needing theory, defined the transformational leadership style as a leader who encourages the members of an organization to pursue higher-level work goals through his or her noble moral accomplishments and outstanding leadership. Bass (1995) defined it as the leader giving individual care and intellectual stimulation to the members of the organization through his or her unique charisma and personal characteristics to improve the work involvement of the members of the organization and the work performance of the whole team. By sharing positive visions, transformational leaders internalize the values of their subordinates and urge them to pursue higher goals and objectives beyond immediate interests (Howell and Avolio, 1993). In the context of education, Leithwood (1994) clearly proposed that the transformational leadership style in schools could promote teachers' identification with organizational goals by building a cooperative institutional culture, motivating teachers to develop continuously, and ultimately achieving the development and reform of schools. Transformational leadership, according to Peng et al. (2022), enhanced teachers' work satisfaction through PLCs. Additionally, some studies have indicated that the transformational leadership style of preschool principals can improve teachers' collective efficacy (Dussault et al., 2008), stimulate teachers' professional learning and motivation (Thoonen et al., 2011), and promote the development of teacher leadership (Li and Liu, 2020). Under the transformational leadership style of the preschool principal, teachers are motivated and prepared to assume the responsibility of professional development and the management of instructional leadership (Printy et al., 2009).

The transactional leadership style was first proposed by Burns (1978). According to his perspective, a transactional leadership style refers to leaders selectively providing subordinates with appropriate support and remuneration after understanding their working abilities to meet their material needs for survival and help them successfully complete their tasks. In an equal exchange, subordinates need to be paid for their labor to receive the corresponding reward and support promised by their leaders. Therefore, the transactional leadership style places more emphasis on the exchange of interests or resources between leaders and subordinates. Later, Bass (1995) further generalized the view of this leadership style as focusing on the exchange of resources and the rules of reward and punishment between the leader and the subordinate. Transactional leadership style, which, in essence, is a transactional process, urges subordinates to work hard with the help of spiritual incentives and material rewards. The transactional leadership style emphasizes the exchange of benefits and material incentives, but it is crucial to establish a reward and punishment incentive mechanism and to provide an indispensable material guarantee for improving teachers' innovative teaching behavior. When teachers are under the management of a leader with a transactional leadership style, they know that future rewards or punishments depend on whether their behaviors meet expectations. Therefore, they need to achieve goals through self-leadership and intrateam leadership (Marshall et al., 2012).

The laissez-faire leadership style was first defined by Lewin to describe a leader who rarely uses his or her managerial authority when leading a team and habitually takes a nondirective and dismissive attitude toward subordinates, rarely giving direction to team members about the team's tasks and goals. Bass later put forward that the laissez-faire leadership style is essentially a kind of leadership behavior in which the leader allows subordinates to freely develop without assuming relevant management actions and in which subordinates are often in a state of being overwhelmed. Some categorize the laissez-faire leadership style as the antithesis of the transformational leadership style and transactional leadership style in which the leader-subordinate deal is made (Bass and Avolio, 1993). However, the laissez-faire leadership style is extremely common in the actual workplace (Aasland et al., 2009). Some scholars argue that because laissez-faire leaders are not involved in the work of their subordinates, they are motivated to adopt assertive behaviors such as making demands, expressing emotions, and displaying assertiveness to fill the lack of leadership influence and maximize subordinates' own leadership (Deluga, 1990). However, the negative results of the laissez-faire leadership style are still predominant. The laissez-faire leadership style of preschool principals negatively affects teachers' collective efficacy (Dussault et al., 2008), job performance and satisfaction

(Imhangbe et al., 2019). Moreover, the laissez-faire leadership style affects the quality of interpersonal relationships within the school and is detrimental to conflict resolution among teachers (Chandolia and Anastasiou, 2020). As laissez-faire leaders relinquish their responsibilities, subordinates may compete for power and influence abdicated by the laissez-faire leader, which can lead to interpersonal tensions (Deluga, 1990). Teacher leadership cannot be developed and grow in a laissez-faire environment.

Therefore, the following hypotheses were proposed:

Hypothesis 1a: A transformational leadership style has a significant positive impact on preschool teacher leadership.
Hypothesis 1b: A transactional leadership style has a significant positive impact on preschool teacher leadership.
Hypothesis 1c: A laissez-faire leadership style has a significant negative impact on preschool teacher leadership.

## Psychological capital

In the process of teaching in preschool, teachers confront a variety of difficult jobs and assignments, as well as a variety of obstacles. They are easily defeated by setbacks if their psychological quality is weak. Therefore, psychological quality is one of the key factors for preschool teachers to be competent in their jobs. Luthans argues that psychological capital is a comprehensive source of energy that combines multiple positive psychological states, including self-efficacy, hope, optimism and resilience, which can enhance the quality of one's work and life (Luthans et al., 2005) and widely influence individuals' attitudes and behaviors (Avey et al., 2010; Peng et al., 2013). Different leadership styles have a great impact on the psychological capital of employees and the whole team. There is a significant positive correlation between sincere leadership and employee psychological capital (Woolley et al., 2011). Within the school context, sincere leadership by preschool principals significantly fosters positive psychological capital in teachers (Feng-I. F, 2016). A transformational leadership style positively predicts employees' psychological capital, while psychological capital mediates the impact of transformational leadership on engagement (Yongzhan and Li, 2018) and is also positively associated with team performance (Rebelo et al., 2018). By constructing a vision, transformational leaders are able to help employees clarify their goals and directions and recognize the value and meaning of the work they are doing; these goals and visions, in turn, inspire enthusiasm and increase hope and confidence in the future (Helland and Winston, 2005). Under a laissez-faire leadership style, employees do not receive effective support and motivation from their leaders' behaviors and do not cultivate a sense of trust and confidence in the organization (Baig et al., 2021), thus resulting in a negative organizational environment. Such a leadership style will have a negative impact on the mental health of organization members (Toor and Ofori, 2010).

Therefore, the following hypotheses were proposed:

Hypothesis 2a: A transformational leadership style has a significant positive impact on the psychological capital of preschool teachers.
Hypothesis 2b: A transactional leadership style has a significant positive impact on the psychological capital of preschool teachers.
Hypothesis 2c: A laissez-faire leadership style has a significant negative impact on the psychological capital of preschool teachers.
Hypothesis 3: The psychological capital of preschool teachers has a significant positive impact on preschool teacher leadership.

## Theoretical framework

Leader-member exchange theory (LMX) provides a good theoretical perspective for studying and analyzing the relationship between preschool principal leadership styles, teacher leadership and psychological capital. The uniqueness of this theory lies in its research focus on the dynamic exchange relationship between the leader and the members of the organization and on the mechanisms by which this dynamic exchange relationship affects the work attitudes and behaviors of the members of the organization. LMX is based on social exchange theory, in which the interaction of interpersonal relationships is a central theme. LMX refers to the quality of the exchange relationship between leaders and followers based on trust, respect and obligation. In exchange for a comprehensive view of the leader's support and motivation, the employee will reward the leader with respect, trust, and adequate feedback, thus establishing a relationship with a high level of mutual esteem (Graen and Uhl-Bien, 1995). Individuals who develop high-quality relationships with their leaders will be attached psychologically to their work group (Pan and Lin, 2016). A high-quality leader-member exchange relationship brings good exchange results for leaders and organizational members. Because of the positive effects of a high-quality leader-member exchange relationship, it is beneficial to maintain a positive exchange relationship between leaders and organizational members for a long time (Wilson et al., 2010). From the perspective of leadership style, the transformational leadership style directly affects the quality of the leader-member exchange relationship (Wang et al., 2005; Vermeulen et al., 2022). This study suggests that there is a unique leader-member exchange relationship between the leadership styles of preschool principals, teacher leadership and the psychological capital of preschool teachers. Different leadership styles of preschool principals have different influences on the psychological

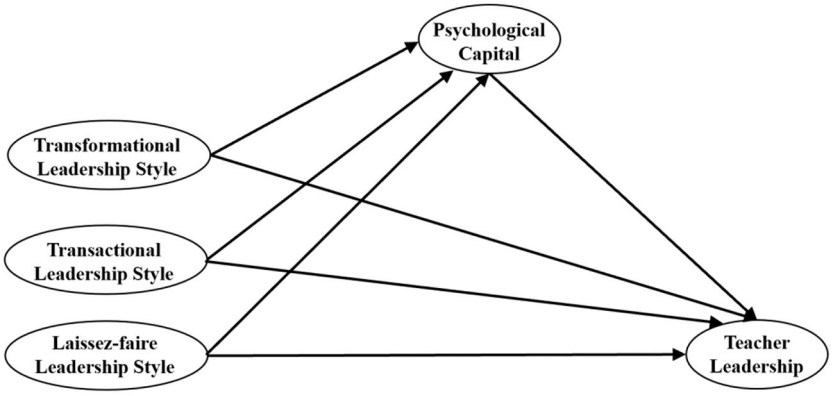


FIGURE 1
Hypothetical model.

state and behavioral practices of preschool teachers. When preschool teachers receive resources and support from preschool principals with different leadership styles, they enter into an exchange relationship with the preschool principals. Thus, the various leadership practices that preschool teachers exhibit at work involve feedback and exchange with the resources provided by preschool principals with different leadership styles.

Therefore, the following hypotheses were proposed:

Hypothesis 4a: A transformational leadership style affects teacher leadership through the mediating role of preschool teachers' psychological capital.

Hypothesis 4b: A transactional leadership style affects teacher leadership through the mediating role of preschool teachers' psychological capital.

Hypothesis 4c: A laissez-faire leadership style affects teacher leadership through the mediating role of preschool teachers' psychological capital.

## Present research

Different leadership styles influence subordinates' work attitudes and behavioral practices (Avolio et al., 1999). The current management system of preschools in China is the principal responsibility system, in which the principal is responsible for all people, things, and objects in the preschool. The different leadership styles adopted by the preschool principal have an impact on the psychological state of preschool teachers and a range of behavioral practices inside and outside the classroom. At present, early childhood education in China is receiving more and more attention from the government and society, and building a high-quality teacher team and improving the quality of early childhood education are the most important tasks of the current education reform. The training and enhancement of teacher leadership is one of the main ways of professional development of teachers, which is not only conducive to the continuous learning of individual teachers, but also can strengthen the professional construction of the teaching team. But most of the research on teacher leadership in the Chinese context has been conducted on primary and secondary school teachers and university teachers, but less on preschool teacher leadership. The research has focused on the current situation of teacher leadership and its influencing factors, but there is a lack of research to explore the deeper mechanisms underlying preschool teacher leadership, especially the relationship between the leadership style of preschool principals and preschool teacher leadership.

Therefore, this study aims to:

1. Investigate the current situations of preschool teacher leadership, psychological capital, and preschool teachers' perceived leadership styles of principals and the differences between the three with respect to different demographic variables.
2. Explore the correlation between principal leadership style, teacher psychological capital and teacher leadership and analyse the influence of different types of preschool principal leadership styles on preschool teacher leadership based on theories and data.
3. Establish a structural equation model to test the mediating role of psychological capital in different preschool principal leadership styles and preschool teacher leadership.

The hypothetical model of the present study is shown in Figure 1.

TABLE 1 Demographics of participants ($N = 294$).

| Demographic characteristic | | N | % |
|---|---|---|---|
| Gender | Male | 10 | 3.4 |
| | Female | 284 | 96.6 |
| Age | <25 | 172 | 58.5 |
| | 26–30 | 70 | 23.8 |
| | 31–35 | 18 | 6.1 |
| | 36–40 | 16 | 5.4 |
| | 40–45 | 14 | 4.8 |
| | >45 | 4 | 1.4 |
| Educational background | High school or less | 5 | 1.7 |
| | Junior college | 87 | 29.6 |
| | Bachelor degree | 189 | 64.3 |
| | Master's degree or above | 13 | 4.4 |
| Seniority | Under 3 years | 194 | 66 |
| | 4–5 years | 49 | 16.7 |
| | 6–10 years | 23 | 7.8 |
| | 11–15 years | 11 | 3.7 |
| | 16–20 years | 8 | 2.7 |
| | Above 20 years | 9 | 3.1 |
| Type of preschool | Public | 197 | 67 |
| | Private inclusiveness | 55 | 18.7 |
| | Private | 24 | 8.2 |
| | Others | 18 | 6.1 |
| Position | Assistant teacher | 161 | 54.8 |
| | Head teacher | 85 | 28.9 |
| | Grade/teaching and research group leader | 10 | 3.4 |
| | Administrative positions | 12 | 4.1 |
| | Others | 26 | 8.8 |

# Materials and methods

## Participants

In this study, preschool teachers from Guangdong Province in China was selected as the research participants. Three hundred twenty-seven pieces of data were collected, and 294 valid questionnaires were recovered, with a recovery rate of 89.91%. Specific demographic information of the sample, including teachers' age, gender, position, educational background, seniority and types of preschools, is shown in Table 1.

## Measures

### Teacher leadership scale

This study uses the Teacher Leadership Scale (TLS) developed by Chinese scholars Wang and Xia (2020) to measure the leadership of preschool teachers. The scale has 19 items in total, including four dimensions, namely leading teaching and professional development; characteristics of teacher leaders; participating in school-wide decision-making; diversity and continuous improvement. The scale is based on a Likert-6 scale, ranging from 1 for "strongly disagree" to 6 for "strongly agree." The overall Cronbach's α of the scale was 0.926, and the internal consistency coefficients of the four dimensions were 0.91, 0.92, 0.87 and 0.87 respectively, indicating that the scale had high reliability.

### Principal leadership styles

The Multifactor Leadership Questionnaire (MLQ-5X) compiled by Avolio and Bass (2001) and the Paternalistic Leadership Scale (PLS) compiled by Cheng et al. (2014) were used to measure the types of leadership styles of preschool principals. The MLQ-5X scale consists of three subscales with 36 items, Transformational Leadership style (20 items), Transactional Leadership style (8 items), and Laissez-Faire Leadership style (8 items). The Likert-5 grading method was adopted for the scale, ranging from "strongly disagree" to "strongly agree." The overall Cronbach's α of the scale was 0.937, and the Cronbach's α values of the four subscales were 0.975, 0.83, and 0.95 respectively, indicating that the scale has high reliability.

### Psychological capital questionnaire

The Psychological Capital Questionnaire (PCQ-24) prepared by Luthans et al. (2007) was adopted in this study. Some words of the Questionnaire were modified appropriately, for example, "company" was changed to "preschool," etc. Therefore, it is suitable to be tested in preschool teachers. A Likert scale of 6 points was adopted, from 1 "strongly disagree" to 6 "strongly agree." A higher score indicates a higher level of psychological capital. The Cronbach's α of the overall scale was 0.90, showing that the scale has good reliability.

## Statistical analysis

First of all, the single-factor ANOVA test was used to test the differences in preschool teacher leadership and teacher psychological capital in teachers' seniority and position. Secondly, the correlation and relationship among these three variables of preschool teacher leadership, preschool principal leadership styles and teacher psychological capital were tested. After the significant correlation and regression of the three variables were verified, finally, a structural equation model with Maximum Likelihood Estimation was used to verify the mediating role of psychological capital between different preschool principal leadership styles and preschool teacher leadership.

TABLE 2 The correlational coefficients of all variables ($N = 294$).

| | | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| 1 | Transformational Leadership Style | 3.97 | 0.75 | 1 | | | | |
| 2 | Transactional Leadership Style | 3.75 | 0.65 | 0.686** | 1 | | | |
| 3 | Laissez-Faire Leadership Style | 2.44 | 1.13 | −0.311** | −0.070 | 1 | | |
| 4 | Teacher Leadership | 4.92 | 0.62 | 0.600** | 0.534** | −0.088 | 1 | |
| 5 | Psychological Capital | 4.35 | 0.61 | 0.565** | 0.422** | −0.389** | 0.552** | 1 |

*$p < 0.05$, **$p < 0.01$, *** $p < 0.001$.

SPSS(Version 25.0) and Mplus (Version 8.0) were used for data analysis.

# Results

## Description statistics and correlation matrix

The mean ($M$), standard deviation ($SD$) of each variable and the correlation coefficient between variables are shown in Table 2. The results show that the scores of transformational leadership style ($M = 3.97$, $SD = 0.75$) and transactional leadership style ($M = 3.75$, $SD = 0.65$) are both higher than the theoretical median value of 3, indicating that the two kinds of leadership styles perceived by preschool teachers are at a high level. But the scores of laissez-faire leadership style ($M = 2.44$, $SD = 1.13$) is lower than the theoretical median value of 3, indicating that the two kinds of leadership styles perceived by preschool teachers are at a low level. The score of teacher leadership ($M = 4.92$, $SD = 0.62$) is higher than the theoretical median value of 3, indicating that the preschool teacher leadership is at a high level. The score of psychological capital ($M = 4.35$, $SD = 0.61$) is higher than the theoretical median value of 3, indicating that the psychological capital of preschool teachers is at a high level.

Preschool teacher leadership was positively correlated with transformational leadership style ($r = 0.600$, $p < 0.001$) and transactional leadership style ($r = 0.534$, $p < 0.001$). There is no correlation between laissez-faire leadership style and preschool teacher leadership ($r = 0.088$, $p > 0.05$). Psychological capital of preschool teachers was positively correlated with transformational leadership style ($r = 0.565$, $p < 0.01$) and transactional leadership style ($r = 0.422$, $p < 0.01$), while the psychological capital of preschool teachers was negatively correlated with laissez-faire leadership style ($r = -0.389$, $p < 0.01$). There was a significant positive correlation between preschool teacher leadership and psychological capital ($r = 0.552$, $p < 0.01$).

## Variance analysis

The mean difference test was conducted for the two variables (teacher leadership, psychological capital). The results are shown in Table 3. In terms of teacher leadership, there were significant differences for seniority, $F = 4.876$, $p < 0.01$. *Post-hoc* analysis using the Scheffé *post-hoc* criterion for significance indicated that the leadership of preschool teachers with 3 years or less of seniority ($M = 4.80$, $SD = 0.62$) was significantly lower than who with more than 4 years of seniority ($M = 5.14$, $SD = 0.59$), and reaches the peak within the range of 11–15 years of seniority ($M = 5.33$, $SD = 0.46$). There were significant differences for position, $F = 3.216$, $p < 0.01$. *Post-hoc* analysis showed that the score of assistant teachers ($M = 4.82$, $SD = 0.60$) was significantly lower than that of teachers in more senior positions. The leadership level of administrative teachers was the highest among all the teachers ($M = 5.29$, $SD = 0.41$).

In terms of psychological capital, there was significant difference for seniority, $F = 5.569$, $p < 0.05$. *Post-hoc* analysis showed that the score of preschool teachers with 11–15 years of seniority ($M = 4.89$, $SD = 0.42$) was highest. There was significant difference for position, $F = 3.508$, $p < 0.05$. *Post-hoc* analysis indicated that score of assistant teachers ($M = 4.26$, $SD = 0.63$) was significantly lower than that of teachers in more senior positions.

## Mediation test of psychological capital between principal leadership styles and teacher leadership

The purpose of this study is to explore the relationship between the principal leadership style, the preschool teacher leadership and the psychological capital of preschool teachers, which focusing on the mediating effect of psychological capital. On this basis, a structural equation model was constructed, and the model results are shown in Figure 2.

According to (Hu and Bentler, 1999), when the model fit index is $\chi^2/df \leq 3$, CFI $\geq 0.90$, TLI $\geq 0.90$, RMSEA $\leq 0.08$ and SRMR $\leq 0.80$, the model is considered to be a good fit. The fitting index of the model is $x^2 = 6359.37$,

10.3389/fpsyg.2022.1006184

TABLE 3 Variance analysis ($N = 294$).

| | Variable | Group | *M* | *SD* | *F* |
|---|---|---|---|---|---|
| Teacher leadership | Seniority | Under 3 years | 4.80 | 0.62 | 4.876*** |
| | | 4–5 years | 5.14 | 0.59 | |
| | | 6–10 years | 5.09 | 0.49 | |
| | | 11–15 years | 5.33 | 0.46 | |
| | | 16–20 years | 5.19 | 0.56 | |
| | | Above 20 years | 5.18 | 0.46 | |
| | Position | Assistant teacher | 4.82 | 0.60 | 3.216*** |
| | | Head teacher | 5.01 | 0.63 | |
| | | Grade/teaching and research group leader | 5.17 | 0.48 | |
| | | Administrative positions | 5.29 | 0.41 | |
| | | Others | 5.00 | 0.67 | |
| Psychological capital | Seniority | Under 3 years | 4.23 | 0.62 | 5.569* |
| | | 4–5 years | 4.45 | 0.50 | |
| | | 6–10 years | 4.69 | 0.54 | |
| | | 11–15 years | 4.89 | 0.42 | |
| | | 16–20 years | 4.46 | 0.59 | |
| | | Above 20 years | 4.57 | 0.50 | |
| | Position | Assistant teacher | 4.26 | 0.63 | 3.508* |
| | | Head teacher | 4.40 | 0.55 | |
| | | Grade/teaching and research group leader | 4.80 | 0.51 | |
| | | Administrative positions | 4.71 | 0.54 | |
| | | Others | 4.36 | 0.61 | |

*p < 0.05, **p < 0.01, ***p < 0.001.

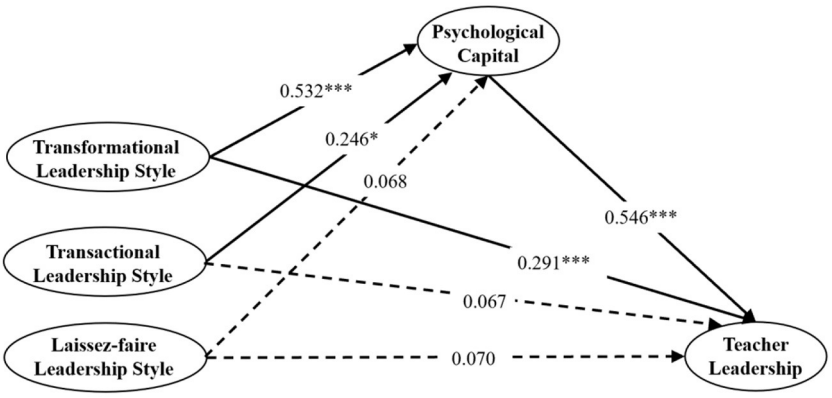


FIGURE 2
Psychological capital as a mediator in the associations between principal leadership styles and teacher leadership.*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Dotted lines indicate non-significant paths.

$df = 2332$, RMSEA = 0.073, CFI = 0.905, TLI = 0.918, SRMR = 0.047. Transformational leadership style has a significant positive impact on psychological capital ($\beta = 0.550$, $p < 0.001$) and teacher leadership ($\beta = 0.316$, $p < 0.001$). Transactional leadership style has a significant positive impact on psychology capital ($\beta = 0.207$, $p < 0.05$). Psychological capital has a significant positive impact on teacher leadership ($\beta = 0.532$, $p < 0.001$). Transactional leadership style ($\beta = 0.061$, $p < 0.05$) has no significant impact on teacher leadership. Laissez-faire leadership style has no significant impact on teacher leadership ($\beta = -0.013$, $p < 0.05$) and psychology capital ($\beta = 0.113$, $p < 0.05$).

TABLE 4 Mediation analysis of psychological capital on the associations between principal leadership styles and teacher leadership.

| | | | Mediation analysis | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | 95% CI | |
| Hypothesis | Independent variable | Dependent variable | Mediation variable | Estimates (SE) | *p* | Lower | Upper |
| 4A | Transformational leadership style | Teacher leadership | Psychological capital | 0.204(0.061) | 0.000 | [0.107, 0.352] | |
| 4B | Transactional leadership style | | | 0.253(0.037) | 0.000 | [0.228, 0.449] | |
| 4C | Laissez-faire leadership style | | | −0.003(0.021) | 0.891 | [−0.045,0.037] | |

To examine the indirect effects of psychology capital, mediation analysis based on 5,000 bootstrapping samples was conducted. The results were shown in Table 4. In the Hypothesis 4A pathway (Transformational leadership style—Psychology capital—Teacher Leadership), the mediating effect quantity was 0.204, $p < 0.001$, the 95% confidence interval was [0.107, 0.352], the mediating effect ratio (ab/c) was 48.2% (0.204/0.423). Therefore, it can be assumed that psychological capital plays a significant intermediary role in transformational leadership style and teacher leadership. In the Hypothesis 4B pathway (Transactional leadership style—Psychology capital—Teacher leadership), the mediating effect quantity was 0.253, $p < 0.001$, the 95% confidence interval was [0.228, 0.449], the association between transactional leadership style and teacher leadership is non-significant. Therefore, psychological capital fully mediated the relationship between transactional leadership style and teacher leadership. In the Hypothesis 4C pathway (Laissez-Faire leadership style—Psychology capital—Teacher Leadership), all paths are not significant and there is no mediating effect.

# Discussion

## Teacher leadership

On the whole, preschool teacher leadership is at an above-average level. First, since comprehensive education reform was launched in most areas of China, teacher-related policies in early childhood education reform have been considered a decisive factor in improving the quality of early childhood education, among which improving preschool teacher leadership is one of the important factors for the success of education reform (Wang and Ho, 2020). In this context, an increasing number of preschool teachers have gradually realized that teacher leadership has a positive influence and that all teachers could be the subject of exercising leadership. Second, preschool teacher leadership is also related to the management style of the preschool principal. The authority openness of the preschool principal is one of the key factors affecting the leadership of preschool teachers (Wang, 2018). When the principal recognizes the importance of teacher leadership to the development of the preschool, he or she will give much support and guidance to the performance of teacher leadership, delegate more decision-making and management rights to teachers, and encourage teachers to exert their positive influence (Devos et al., 2014). LMX theory emphasizes the dynamic relationship between managers and organization members (Graen and Uhl-Bien, 1995). Transferred to the organizational relationships in a preschool, when the principal delegates more leadership to teachers, it is beneficial for teachers to develop good role perceptions, take on more responsibility for additional roles, and use their expertise and competence to exert positive, nonpowerful influence over children, other teachers, and the whole school.

Preschool teacher leadership increases with years of teaching seniority and is lowest for teachers with <3 years of teaching experience. With the increase in teaching seniority, teacher leadership also gradually improves, reaching the highest level at 11–15 years of teaching seniority. Although it declines later, the range is not significant. According to the five-stage theory of teacher professional development proposed by Berliner (1988), teachers with <3 years of teaching experience are at the stage of novice and advanced beginners, who are trying to adapt themselves to the new environment and pay less attention to teaching and the decision-making of school affairs. With the increase in teaching seniority, novice teachers become experienced teachers, and their focus gradually shifts to activities and children at schools. They become more competent and have more time to pay attention to the decision-making of school affairs. With the accumulation and precipitation of teaching experience, the teachers with more seniority receive more attention from the principal and have more say in the decision-making of school affairs, which can effectively develop their leadership.

There is a significant difference in the leadership of preschool teachers in terms of their positions. It is shown that assistant teachers have the lowest scores, while the teachers of administrative positions, such as deputy principals and grade leaders, have the highest scores. Rönnerman et al. (2017) described teachers such as deputy principals and grade leaders as positionally between the principal and the staff and philosophically as a leader among peers as a "middle

leader." Compared with preschool principals, middle leaders in preschools bear more responsibility to manage the whole preschool, such as the grades or the teaching and research groups. They are both managers and executors. Therefore, the improvement of middle-level teachers' leadership is the result of the accumulation of continuous experience in daily management and execution processes.

## Principal leadership styles

Numerous studies of principal leadership styles have shown that the transformational leadership and transactional leadership styles are most frequently exhibited among the school leadership styles, while the laissez-faire leadership style is less common (Li, 2015; Ballaschk et al., 2017; Chandolia and Anastasiou, 2020; Kirkiç and Balc, 2021). In this research, the transformational leadership style of principals scored the highest on the "intellectual stimulation" dimension. Bass and Avolio (1993) defined "intellectual stimulation" as the leader articulating new ideas that prompt followers to rethink conventional practice and thinking. LMX theory suggests that managers will be more supportive of and inspirational to organizational members when they build high-quality leader-member exchange relationships with them (Graen and Uhl-Bien, 1995). When teachers encounter new problems in teaching, such as parental work or scientific research work, the principal encourages teachers to consider problems from new and different perspectives, constantly exercises their problem-solving skills and encourages them to look at problems as a spark of different ideas colliding. In addition, emotional factors are also included as one of the factors affecting transformational leadership style. LMX theory suggests that a high-quality leader-member exchange relationship includes an emotional exchange between managers and organizational members. Preschool is a female-dominated work environment, and the principal and the teachers are mostly women. Actually, female leaders are normally sensitive and considerate and can find the emotional needs of teachers in their work and give them more specialized caring in a timely manner. Similarly, female teachers are also eager for the emotional support and work motivation given by their superior leaders.

Bass and Avolio (1993) defined the two dimensions of the transactional leadership style as the leader providing rewards contingent on performance (contingent reward) and the leader taking corrective action in anticipation of problems (management-by-exception-active). In this study, the score of the "contingent reward" dimension of the transactional leadership style of principals was higher than that of the "management-by-exception-active" dimension. This shows that in the management process of preschools, instead of focusing on "What are the teachers' mistakes? How should I correct them?", the principal focuses more on "What are the needs of the teachers? What kind of help or reward can I give to the teachers to motivate them to serve the preschool and achieve teaching goals?" LMX theory shows that managers and organizational members are in dynamic exchange relations that influence each other (Graen and Uhl-Bien, 1995). To establish a high-quality leader-member exchange relationship with a team of teachers who have relatively high levels of education, theoretical knowledge and practical experience in teaching, the principal is more inclined to pay attention to the teachers' needs at work and provide them with assistance or incentives in exchange for the teachers bringing more resources to the institution. In addition, due to teachers' high educational and personal quality, there are few behaviors that do not comply with the rules and regulations of the preschool at work; thus, the principal does not need to pay too much attention to the teachers' wrong behaviors.

In this study, the laissez-faire leadership style scores were the lowest, indicating that preschool teachers are less likely to perceive the principal's hands-off approach as effective management today, and Dussault et al. (2008), Kirkiç and Balc (2021) have shown similar results. Preschool teachers regard their principal as a leader who can take on the responsibility of preschool management and make a difference. LMX theory suggests that managers and organizational members interact in a dynamic exchange relationship. This means that when managers give more autonomy to organizational members, they will have a greater sense of identification with the organization, actively participate in the affairs of the organization, and be willing to take on more leadership roles. However, this autonomy does not refer to the laissez-faire leadership style and does not indicate that the principal would ignore management and guidance. The new management style advocates that the principal should give teachers a degree of decentralization and empowerment (Sebastian et al., 2016), but it does not mean that they can stay out of the loop. The director should lead the teachers to participate in the various affairs of the school together and lead all team members to participate in leadership practices with their professional management knowledge and extensive leadership experience.

## Teacher psychological capital

In this study, the psychological capital of preschool teachers is generally above the average level, indicating that preschool teachers can have a positive psychological state at work, remain optimistic and believe that they can solve challenges and difficulties. This is consistent with the results of Fu (2015), Cheng and Gan (2020), and Hong et al. (2022). First, it is related to the object of education that preschool teachers face. Children aged 3–6 are innocent and lively. Children's lovely smiles, pure love and unconditional trust for teachers can, to a certain extent, relieve or even cure their broken hearts due to excessive work pressure and enhance the psychological

capital of preschool teachers (Hong et al., 2022). Second, it can also be related to the increasing emphasis on early childhood education in Guangdong Province and across China. In 2018, the Department of Education of Guangdong Province in *The Third Action Plan for The Development of Preschool Education in Guangdong Province (2017-2020),* clearly indicated that the government will gradually improve the treatment of equal pay for equal work for teachers in public preschools, integrate all preschool education workers into the social security system, and require preschools to buy endowment insurance for them. The state and government departments at all levels should guarantee the material needs of preschool teachers to meet their basic survival and developmental needs so that they can find their great social importance and see the bright prospects of their careers. Therefore, they would have more confidence and hope in this career and could also maintain an optimistic psychological state at work.

### Relationship between preschool principal leadership styles, teacher leadership, and psychological capital

The transformational leadership style of preschool principals can directly and positively influence the leadership of preschool teachers, which is similar to the results of Leithwood and Jantzi (2006) and Li and Liu (2020). When school principals adopt a transformational leadership style to integrate the social and human capital of the school, they incorporate teachers into the decision-making and management of the school (Li and Liu, 2020). In the process of accomplishing the various developmental goals of the preschool, the principal will regard each teacher as an independent individual, encourage the teachers to give full play to their strengths to complete various tasks and allow them to have their own characteristics to exert their own leadership. The transformational leadership style of principals also indirectly affects the leadership of preschool teachers through the mediating role of psychological capital. Transformational leadership emphasizes sharing and the development of teachers' collective capacity (Gkolia et al., 2018), which is often reflected in the professional learning community (PLC) of preschool teachers (Peng et al., 2022). In a professional learning community, the charismatic influence of the director and the motivation of good prospects can make preschool teachers feel a sense of belonging and identification with the organization and maintain a positive psychological state in their work. Transformational leaders also provide teachers with a relaxing, democratic, innovative and transformative work atmosphere that enables them to boldly innovate teaching and actively cooperate with other colleagues. A good psychological state not only allows preschool teachers to concentrate more on their teaching practice but also to be more willing to take on additional roles, actively participate in making decisions and demonstrate their abilities to make a positive impact on the development and management of the school.

It is worth noting that in this study, the direct effect between the transactional leadership style of principals and preschool teacher leadership is not significant, but the mediating effect through psychological capital is significant. This means that the transactional leadership style of principals indirectly affects the leadership of preschool teachers through the intermediary role of their psychological capital. This also echoes the point of view of Marshall et al. (2012) and Li (2015). As a leadership style based on the exchange process, transactional leaders tend to motivate their employees to complete tasks more effectively by setting specific goals or breaking them down into actionable steps (Yongzhan and Li, 2018). In fact, a positive psychological state can help preschool teachers exert their talents more and have a positive influence on children and colleagues in schools. In the step-by-step process of achieving the goals set by leaders, teachers need to explore various new forms of teaching activities and organization with a more positive mindset to continuously improve their work and teaching skills. In addition, teachers are also able to share their unique teaching ideas, plenty of teaching and parenting experience and skills in handling parents with other teachers. Through mutual cooperation and communication among teachers, they can exert a positive influence on their colleagues and increase their sense of efficacy in collective cooperation and their psychological capital, thus promoting the development of preschool teachers' leadership.

There was no direct effect between laissez-faire leadership style and preschool teacher leadership, nor was there an indirect effect on preschool teacher leadership through the mediation of psychological capital. Analyzing the related reasons, we can draw the following conclusions. First, influenced by the hierarchical management structure in China, the management system of Chinese preschools is under the responsibility of the preschool principal (known as "Yuan Zhang" in Chinese), i.e., who is wholly responsible for handling the work of preschool. He or she is responsible for major issues and decisions such as the missions of preschool, training programs, and teachers' appointments (Jiang et al., 2016). Within this framework of responsibility, the principal must fulfill his or her responsibility to manage the whole school's teachers and teaching or be held accountable by the relevant higher authorities.

## Implication

### For preschool principals

As the manager and head of the preschool, the principal's own actions can influence the perceptions and practices of the organization's members. In addition, it may affect the organizational climate of the school as a whole. When the

principal is able to actively engage in leadership practices that set an example for teachers, preschool teachers are influenced by the principal's positive behavioral practices and are able to look to the principal and learn from her or his own leadership practices. Therefore, in management and teaching, the principal should actively exert his or her unique charisma and leadership skills to influence preschool teachers' perceptions of leadership practices, to "practice what you preach" and to "teach by example" as management guidelines, and to strive to set an example for preschool teachers with his or her own leadership practices.

When preschool teachers are leaders who have a positive, non-powerful influence on children, colleagues, and even other people in the preschool, they demonstrate the characteristics of leaders who can influence others and lead them to progress. In addition, each teacher is an individual and must shine differently from others in the group. As the manager of the whole team, the principal should be good at discovering the shining points of each teacher, tapping into his or her leadership talents, encouraging teachers to take on leadership roles other than teaching based on their specific situations and personality characteristics, and bringing their professional strengths and authority to bear on other teachers and lead the whole preschool to a higher level of development.

### For preschool teachers

Preschool teachers need to change their role and understanding in a timely manner. Preschool teachers often habitually think of themselves as just a teacher, a follower of the director and management, and do not yet have a clear understanding of the identity of a teacher leader. Wei and Cheng (2022) suggests that having a certain sense of leadership within is a prerequisite for the development of teacher leadership, and that teachers need to recognize that they can also exert positive influence on others as well and can lead team members to grow together. Therefore, the first prerequisite for developing preschool teachers' leadership is to promptly change preschool teachers' orientation and understanding of their own roles, and preschool teachers must realize that they can be non-powerful "leaders" who have positive influence on children, colleagues, and various personnel in the school. This "leader" has nothing to do with position or power, but rather with the recognition and learning of other teachers, school staff and parents for their excellent teaching and professional knowledge.

Teacher leadership is essentially a job-embedded professional development that enables educational reform and instructional improvement through ongoing, site-based professional development (Poekert, 2012). Preschool teachers need to strengthen their professional skills in order to promote leadership. They can rely on a variety of resources provided by the school to enhance their professional talents, such as active participation in professional learning communities (PLCs). In PLCs, educators work together to enhance student learning through inquiry questions; identify goals for educator learning; engage in collaborative learning through formal and informal professional learning strategies such as lesson study, assessment of student work, and peer coaching; reflect on practice; and hold each other accountable for improved practice and outcomes. PLCs are essential to support teacher leaders in overcoming isolation and other challenges they may encounter when assuming leadership responsibilities.

In addition to the above, preschool teachers need to maintain a positive mental state. It is inevitable that preschool teachers will encounter many teaching problems and challenges in their work, and sometimes it is difficult for their professionalism to be recognized by others, and they do not have the support and understanding of parents, or even the understanding and help of colleagues or principals. This requires teachers to adjust their mindset and work status in a timely manner, always have enough confidence and hope in the early childhood education, be able to put in some effort when facing various challenges and problems, believe that they are capable of accomplishing them, and be persistent.

## Limitations and future research

When interpreting the findings of this study, it is important to note its limitations. Firstly, to examine whether there is an effect of leadership style characteristics on the individual characteristics of subordinates in a given organization, the participants should include both individual leaders and all subordinates. The results would be more convincing if nested data between leaders and subordinates could be collected and the correlation between the two sides of the data could be demonstrated.

Secondly, the sample size in this study was somewhat limited, and the findings could not be generalized to all the preschools in China. In order to determine whether different organizational structures or management models for preschools can moderate the relationship between leadership styles and teacher leadership, future research could broaden the scope of the participant to include various types of preschools in various regions of China.

Finally, in terms of research content, the mechanism of principal leadership style's influence on preschool teacher leadership has not been studied deeply enough. This research only explores the mediating variable of psychological capital, and many other variables that may affect the principal leadership style and preschool teacher leadership are not mentioned. There may even be chain mediating or moderating variables between the principal leadership style and preschool teacher leadership, which need to be further analyzed in future studies.

## Conclusion

This research, based on leadership-membership exchange theory, took preschool teachers in Guangdong Province of China as participants and analyzed the relationship and the underlying mechanisms of action between preschool principal leadership styles, preschool teacher leadership and psychological capital by distributing a large-scale questionnaire. First of all, the results showed that preschool teacher leadership and psychological capital were at moderate to high levels, with significant differences in terms of seniority and position. The principal leadership styles of preschool are mainly transformational leadership style and transactional leadership style. Secondly, transformational leadership style and transactional leadership style showed significant positive correlations with preschool teacher leadership, and laissez-faire leadership style showed no correlation with preschool teacher leadership. Preschool teacher leadership was significantly and positively correlated with psychological capital. Transformational leadership style and transactional leadership style were significantly and positively correlated with psychological capital, while laissez-faire leadership style was significantly and negatively correlated with psychological capital. Finally, Transformational leadership style can positively influence preschool teacher leadership directly and indirectly through psychological capital; transactional leadership style can only positively influence preschool teacher leadership indirectly through the mediating role of psychological capital. Laissez-faire can neither directly influence preschool teacher leadership nor indirectly influence preschool teacher leadership through the mediating role of psychological capital.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

All procedures followed were in accordance with the ethical standards of the responsible Committee on Human Experimentation [Guangzhou University, Guangdong Province, China] and with the Helsinki Declaration of 1975, as revised in 2000. Written informed consent to participate in this study was provided by the participants.

## Author contributions

LZ designed the research and drafted the manuscript. TW and CL collected and extracted data for analysis. LL and PR provided important ideas and substantial feedback for the study and edited the manuscript. All authors have approved the final version of this article.

## Funding

This work was supported by the Project of Humanities and Social Sciences of Ministry of Education of the People's Republic of China [21YJC880092].

## Acknowledgments

The authors are grateful to all teachers participating in the study for their strong support.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 13 October 2022
DOI 10.3389/fpsyg.2022.1001521



OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

RECEIVED 23 July 2022
ACCEPTED 15 September 2022
PUBLISHED 13 October 2022

CITATION
Yu L and Li Y (2022) A study of practical drawing skills and knowledge transferable skills of children based on STEAM education.
*Front. Psychol.* 13:1001521.
doi: 10.3389/fpsyg.2022.1001521



# A study of practical drawing skills and knowledge transferable skills of children based on STEAM education

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The STEAM education involves children's ability to integrate and apply their knowledge of science, technology, engineering, arts, and mathematics. The application and transfer of interdisciplinary knowledge in practical activities is the structure of STEAM education. This study assesses children's practical drawing skills and transferable skills based on the global features of their realistic figure drawing. The drawings incorporate the visual information and the multidisciplinary knowledge that children acquire. The assessment variables of the global features are observation perspectives, baseline, and comparison. The results showed that most children present their works through the front view. The children of different age groups show differences in express baseline and comparison features. Boys and girls show some variances in baseline features. Moreover, children are relatively unskilled at applying interdisciplinary knowledge in their drawings.

KEYWORDS

**children's drawing, fine arts education, STEAM education, transferable skills, spatial perception, the sense of quantity**

## Introduction

The education in the school fine arts curriculum is discipline-based art education (DBAE) (Broome et al., 2019). The DBAE educational model refers to children learning the foundational knowledge of fine arts, drawing practical skills, and appreciation ability of artworks through the fine arts curriculum (Chalmers, 2019). The purpose of discipline-based art education is to facilitate children's skills in drawing creation. This education model responds to the problem of children's techniques during drawing creation. STEAM education, by contrast, blurs the boundaries between different disciplines. The art curriculum in STEAM education develops children's creative thinking, practical skills, and the ability to think independently (Perignat and Katz-Buonincontro, 2019). The art curriculum in this educational model is an activity-based program (Bazler et al., 2017). Teachers will provide children with thematic art creative activities in STEAM education. Children are encouraged to design the content of the artwork themselves, assemble the materials for the drawing, and search the methods for completing the drawings.

The STEAM education aims to provide children with the practical skills and interdisciplinary knowledge to create artworks. Hence, children's drawing education is training children's drawing skills and fostering the application of multidisciplinary expertise and creative thinking training. This study evaluates children's ability to apply interdisciplinary knowledge during drawing practice based on STEAM education.

The drawings present appearance information about the height, width, volume, texture, and color of objects (Ferretti, 2018; Winner, 2018; Foley and Bates, 2019). The appearance of objects present in children's drawings is available by their visual estimation of the volume and quantity. Children can obtain the quantity sense from the mathematics curriculum (Booker et al., 2015; Albarracín and Gorgorió, 2019). Hence, the drawing creation process involves children acquiring both drawing skills and applying skills of interdisciplinary knowledge. The positional relationship, proportional relationship, and visual angle between objects are the factors that constitute the visual space features of a drawing (Briscoe, 2016; Ferretti and Marchi, 2021). The location distribution of objects in the drawing represents the position information, scale information, and shape information of the object that creators perceive in the life scenarios. Composition features mean the positional relationship between objects, showing the front of the direction, back, left and right, and up and down is compared to another. These compositional features build the sense of depth and field of vision in works. It is feasible to identify the creator's observational habits and drawing capabilities from the position of the figures and objects in the drawings (Gao, 2018). The figures or objects close to the creators will appear in the most visible place in the drawings. The creators will also paint the clothing, decoration, volume, color, and other characteristic information of figures or objects in detail. The proportion of figures or objects far from the creator is smaller than those that are close. And these things will be placed at the back or far from the main elements of the drawing. Accordingly, this study assesses children's drawing ability and application of interdisciplinary knowledge based on the visual space features of their drawings.

## Research background

The role of the fine arts in interdisciplinary STEAM education is to guide children in acquiring knowledge of science, technology, engineering, and mathematics in arts-themed activities. The arts-themed activities require children to sketch their pieces, learn engineering knowledge, prepare the materials for their creation, finish the artwork and present the achievements to classmates (Jeon et al., 2017; Herro et al., 2019; Barnes et al., 2020). These contents also illustrate that children have to acquire scientific, technological, engineering, and mathematical knowledge related to the subject of the creation before they complete the activities. The drawing creation process also forms part of the artistic activity. In the drawing creation process, children will learn to utilize the drawing techniques, design the appearance features of the figures, and apply interdisciplinary knowledge to form the spatial features in their drawings. It is possible to assess the capacity to apply knowledge across disciplines according to the observation perspectives, baseline, and comparison features from children's drawings. Children have the awareness to apply interdisciplinary knowledge in arts-themed activities (Ngamkajornwiwat et al., 2017; Peppler and Wohlwend, 2018; Ahmad et al., 2021; Timotheou and Ioannou, 2021). However, the influences of interdisciplinary knowledge on children's performance about the visual effects of drawings remain further assessed. For this reason, this study will assess children's knowledge transferable skills based on the visual features of their drawings. The observation perspectives, baseline, and comparison features in children's drawings are associated with their perception of spatial concepts (Vujakovic et al., 2018; Krichker, 2021). Understanding spatial concepts is also the foundation for children learning geometry (Stieff and Uttal, 2015; Young et al., 2018; Mix, 2019; Hawes and Ansari, 2020). The learning of geometry knowledge can assist children in establishing their cognitive abilities to classify, measure, and characterize figures (Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). The representation of the distance and size features between different objects in a drawing needs to be based on children's graphical cognitive ability to achieve. Children's understanding of geometry also provides the basis for children's representation of the three-dimensional features of objects in drawings. The spatial features display in children's drawings represent their perception of spatial concepts. Therefore, this study assesses children's ability to apply interdisciplinary knowledge based on the spatial characteristics of their drawings.

STEAM education aims to achieve children's academic skills through practical activities (Quigley et al., 2017). The Chinese primary school mathematics curriculum standards also require teachers to design curriculum content based on real-life situations (Ministry of Education of the People's Republic of China, 2012, 2022). For example, the mathematics textbook involves measuring the length of objects in real life and identifying the direction of buildings in real-life scenarios (Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). The primary fine arts textbooks also include courses on observing natural surroundings. Children need to perceive changes in the color and appearance of plants under different weather conditions and sunlight (Research Group of National Fine Arts Curriculum Standards for Compulsory Education, 2012). These elements indicate that the current stage of compulsory education in China and STEAM education have the same educational purpose in teaching subject knowledge based on life practice. Paintings are the visual information that creators observe based on the objects' location and shape features. The observation perspectives, compositional features, comparison features, and positional features in paintings are the components of the global features of the work (Kandel, 2016; Stanyer, 2020; Bunce et al., 2021; Goldstein and Cacciamani, 2021). When children create drawings, they need to use their visual senses to

estimate the volume and location features of surroundings and then record these features in their drawings. The primary school mathematics curriculum in China involves training related to the visual estimation of the quality of objects and recognition of the orientation (Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). This element also reflects that Chinese children can estimate the appearance of objects. However, children's ability to translate appearance features into drawings need to further assessment. This study therefore assesses children's ability to apply interdisciplinary knowledge based on the viewing perspective, baseline features and comparison features of their drawings.

# Materials and methods

## Content for the research

This study assesses children's knowledge transferable skills through the observation perspectives, baseline feature and comparison feature of their drawings. The experimental component of the study consisted of a drawing creation task. The drawing task requires asking children to draw a piece of work contain persons and a real-life scene. There is no limitation on the gender and age of the people in the drawing. Before creating drawings, children need to learn the characteristics of the structure, color, volume, and texture of objects associated with life scene theme. Objects from life scenes are familiar and accessible to children. Children can draw regarding the actual appearance of objects. These observations and drawing processes also ensure that the children's work is closer to the requirements of the test task. Realistic drawing is a record of people's visual experience. In drawing creation, children need to show the observed features of shape, height, texture, texture, and location relationship of objects in their works. Therefore, children's knowledge transferable skills in this study is assessed by the composition, structure, and location relationship features between objects in their drawings.

## Participants

The total number of children who participated in the test was 1,000, including 526 girls and 474 boys. These children's intelligence levels are within the normal range. The cultural environment, educational level, and economic development level affect the academic skills of children (Rosselli and Ardila, 2003; Ozer, 2009; Becker et al., 2013). To avoid the effects of these factors on this test we choose children from the same city as the study participants. The content of the textbooks and the curriculum used in schools was also consistent among the children who participated in the test (Ministry of Education of the People's Republic of China in 2010, 2019 and The Education Department of Jilin Province, 2018). All the children who participated in the test were between the ages of 7 and 12, with 282 children aged 7–8 years, 398 children aged 9–10 years, and 320 children aged 11–12 years (Table 1). The classification of age groups is based on children's academic ability and cognitive level. These children were classified into three age groups based on the content of their school mathematics curriculum and the content of the Chinese primary school mathematics curriculum standards (Ministry of Education of the People's Republic of China, 2012 and Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). Furthermore, the drawing data used for this study were completed by children in six-year public elementary schools in China. All of these students were enrolled in schools that had fine arts classes. Therefore, the children who participated in the test had experience in drawing before the test.

TABLE 1 Gender and age distribution.

| | Gender | | Age | | | Total |
|---|---|---|---|---|---|---|
| | Girls | Boys | 7–8 years old | 9–10 years old | 11–12 years old | |
| N | 526 | 474 | 282 | 398 | 320 | 1,000 |

## Data preparation

Before the drawing test, children and their teachers have been told the content and purpose of the drawing test. Children were required to complete the drawing test independently within 40 min. They were not given any hints about drawing techniques, material application, or creative ideas during the test. This step ensures that their drawings more accurately reflect their drawing abilities.

## Materials

Children utilize the A4 (210 mm × 297 mm) paper during the drawing task. Using A4 size paper can help children to better complete the drawing. The smaller paper, such as A5 and B6, has a limited drawing area. This condition will disturb children from drawing the details of figures or scenes. Oversized drawing paper (e.g., B4, A3 paper) has too much blank space. This condition may cause children to be unable to complete drawing within the time specified. Children's drawings may show incomplete scene content. As for drawing tools, children can choose pens according to their preference during the test. Different types of paintbrushes hold correspond to lines and color features. For instance, watercolor pens present thicker lines. Pencils, colored pencils, pens, and ballpoint pens deliver fine lines. On the one hand, children may choose brightly colored watercolor pens to highlight the main content of the drawing. For example, emphasize the contour lines of the figures and objects in the drawing. On the other hand, some children may prefer to use pencils, colored pencils, pens, and ballpoint pens to show the detailed features of

the objects in the drawing. Children may use these drawing tools to express the details of the plant's leaf veins, flower stamens, and the figure's eyebrows and hair. Watercolor pens present a higher brightness of color than colored pencils, pencils, pens, and ballpoint pens. Some children may tend to create brightly colored or light-toned works. This study assesses the shape and position of objects according to children's viewing perspective. The color and texture of the drawing materials do not determine the positional and shape characteristics of the objects in drawings. Also, the ability to apply material is not the evaluation indicator for this study. Therefore the color effects presented by different painting materials will not affect the results of this study. If the children's drawing tools are specified in advance, it may change their original creative drawing habits. Limiting drawing tools may affect the expression of textural features of lines and detailed features in children's work. Drawing tools familiar to children will reduce the time it takes for children to adjust new drawing materials. Allowing children to choose drawing materials according to their habits may lead them to participate more rapidly in creating paintings.

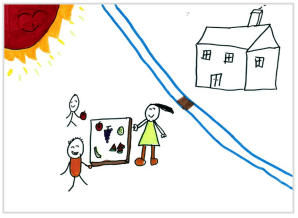
## Coding

Drawings are result from the integration of information about the appearance features of children's observation, such as the observer's angle of viewing the object and the position relationship between the observer and the observed object. The data evaluation in this study relied on assessing the observation perspective, the position of the baseline, and the comparison relationship between the objects and the figures in children's drawings (Table 2).

The types of observation are classified according to the person's observation perspective of objects in space (Talipov and Aliev, 2021 and Talipov, 2021). The observation perspective includes front view, side view, plan view, upward view, and mixed view. The child obtains the front view from the frontal view of the objects or figures. For example, the figures and the mountain in "Front View 1" are created based on the front view (Table 2). The position and orientation information of the figures in "Side View 2" indicates that the creator observes the characters and environmental scenes from the right side (Table 2). Moreover, the figures and the lawn are mainly located on the right side of the work. Therefore, "Side View 2" is classified in the category of the side view. The plan view is obtained by looking from the top to the bottom of the object. Drawings with plan views features will have baselines or objects that divide the drawing area. Also, the ground plane area in these works is larger than the facade area. For example, "Plan View 3" in Table 2, the fence divides the space between the ground plane and the facade. The ground plane area in "Plan View 3" is larger than the elevation area. The observer obtains an upward view from the bottom to the top of the object. The visual effect of the objects close to the creators is more prominent than those far away from them. Also, vanishing points may appear in such drawings. The vanishing point is formed by two or more lines representing parallel lines stretching toward the horizon line until they converge. "Upper View 4" in Table 2 shows a drawing created from an upward view. The two figures in the work jointly present foreshortening effects. The edge lines on either side of the road stretch toward the horizon line until they converge to form the vanishing point of the image. In addition, for children who cannot represent or distinguish viewing perspectives, at least two kinds of viewing perspectives may be present in their works. This type of works is classified as mixed view drawings. For example, "Mixed View 5" in Table 2 shows a drawing with mix view. Children create the figures in this work base on frontal observation. However, the viewpoint of the objects close to the figures is constructed based on the plan view. There are two perspective views present in this drawing. Thus, this drawing is categorized as mix view.

The role of baselines in children's drawings is to create and divide different painting spaces (Morrison, 2013; Strauss, 2021). Baselines are also representative features of children's cognition of painting spatial. Some children have a weak ability to express the ground features in their works (Burkitt et al., 2003; Terton et al., 2022). This issue will cause the missing baseline in their drawings. Other children capable of expressing ground features may draw objects on the baseline or remove objects on either side of the baseline (Burkitt et al., 2019). The baselines are the children's understanding of the concept of space. Baselines express the children's ability to represent three-dimensional space within a two-dimensional space. The baseline location is evaluated in three aspects: without a baseline, objects drawn on the baseline, baseline divides the space area. The lack of a baseline in pieces indicates that the child did not create the drawing with a sense of dividing the ground plane and facade area. "Baseline 1" in Table 2 is a drawing without a baseline. The background of this drawing is red. There are no lines that distinguish the ground plane from the facade area. Thus, this drawing represents a two-dimensional space feature. The lack of three-dimensional space also contributes to the lack of visual depth in the drawing. Depth is related to the front-to-back position of different objects in pieces. So the lack of baseline in the drawing also causes the positional relationship between objects to blurring. Some works contain the lines used to divide the drawing area. However, figures or objects in these drawings are arranged on a baseline. This type of work shows that children have a sense of representing the ground plane. Their awareness of the facade space is limited. "Baseline 2" in Table 2 shows an example of figures and objects arranged on a baseline. The child who created this drawing uses the baseline as a tool to support objects and figures that can be stable on the ground. However, this drawing lacks a description of the object's front and back position relationship. So this drawing only represents two-dimensional visual space. A baseline that divides the space area means a line dividing the drawing's space area. The figures and objects in pieces are located above and below the baseline. These drawings display the existence of both flat and three-dimensional space. It also shows that the children who created this type of drawing are aware of creating three-dimensional space in

TABLE 2 Coding of global features.

| Global features | | Examples |
|---|---|---|
| Observation perspectives | Front view 1 |  Front View 1 |
| | Side view 2 |  Side View 2 |
| | Plan view 3 |  Plan View 3 |
| | Upward view 4 |  Upward View 4 |
| | Mixed view 5 |  Mixed View 5 |
| Baseline | Without baseline 1 |  Baseline 1 |

*(Continued)*

TABLE 2 (Continued)

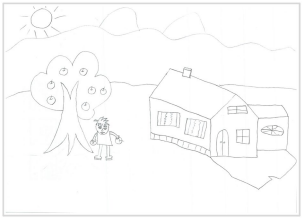
| Global features | | Examples |
|---|---|---|
| | Objects drawn on baseline 2 |  Baseline 2 |
| | Baseline divided the space area 3 |  Baseline 3 |
| Comparison | Wrong comparison 0 |  Wrong Comparison 0 |
| | Distance comparison 1 |  Distance Comparison 1 |
| | Proportion comparison 2 |  Proportion Comparison 2 |
| | With distance and proportion comparison 3 |  Distance and Proportion Comparison 3 |

TABLE 3 Distribution of global features.

| Features | Types of features | Percent % | Frequency | Total |
|---|---|---|---|---|
| View | Front view | 80.2 | 802 | 1,000 |
| | Side view | 0.3 | 3 | |
| | Plan view | 3.3 | 33 | |
| | Upward view | 4.4 | 44 | |
| | Mixed view | 11.8 | 118 | |
| Baseline | Without baseline | 39.8 | 398 | |
| | Objects placed on the baseline | 28.1 | 281 | |
| | Baseline divided the drawing areas | 32.1 | 321 | |
| Comparison | Without or wrong comparison | 35.8 | 358 | |
| | Proportion comparison | 34.4 | 344 | |
| | Distance comparison | 10.9 | 109 | |
| | Distance and proportion comparison | 18.9 | 189 | |

drawings. For example, a line behind the house and tree divides the ground plane from the facade drawing area in "Baseline 3" (Table 2). This line separates the house, tree, or figure from the mountain and sun in the drawing. Therefore, "Baseline 3" is classified as a drawing with a baseline that divides the space area.

The position and proportional relationship between different objects constitute the visual–spatial effect of the drawing. The position and proportion of different objects are related to the spatial depth of the drawing (Farmer et al. 2018; Terton et al., 2022). For example, objects in works close to the observer have a larger volume than those far away. The position and proportional relationship between different objects is also a sign to distinguish the close and distant view of the drawing (Metin and Aral, 2020). The comparison assessment is divided into four types: the wrong comparison, distance comparison, proportion comparison, and distance and proportion comparison. The comparison in this study assesses the relationship between the key elements such as plants, animals, people, houses, and mountains. However, this study will not assess the sky elements such as sun, clouds, stars, moon, and rainbow. The objects on the same horizontal line have opposed to realistic proportion features that will be classified in the category of the wrong comparison. For example, the figure and the house in "Wrong Comparison 0" are on the same horizontal line and have the same height (Table 2). There is a wrong proportional relationship between the house and the figure. Therefore, this work is classified in the category of the wrong comparison. The distance comparison is related to the contrast between objects' front and back positions. The drawing only contains the relationship between the front and back positions. If there is a distance comparison between objects in the drawing and there is no proportion comparison between different types of objects on the same horizontal line, then the drawing is classified as a distance comparison item. "Distance Comparison 1" in Table 2, there is a distance relationship between the figure and the trees. So this drawing is classified as a distance comparison. If drawings only contain a proportional comparison feature between different objects on the same horizontal line, this type of drawing will be classified in the category of proportional comparison. "Proportion Comparison 2" in Table 2 shows a piece of drawing example of a proportional comparison between plants and figures. The drawing includes both distance and proportional features belonging to the distance and proportion comparison category. "Distance and Proportion Comparison 3" in Table 2, there is a distance comparison between the fence and the plants, figures, and houses. There is a proportional comparison between the figure, the house, and the plant. So this drawing belongs to the category of distance and proportion comparison.

## Data analysis

Most of the children represent the figures, objects, and scene environment of the drawing based on the front view (Table 3). Only 0.3% of the children created their works by drawing the sides of objects or people. The observation view results show that plan views, and upward views accounted for 3.3 and 4.4% of the total number of drawings. This result indicates that most children have more experience observing the frontal view of objects than other observation perspectives. Besides, the statistical results show that 11.8% of the children's drawings have mixed views. These results indicate that children have less express experience with the sides of objects or figures in their works.

The role of the baseline in children's drawings is to divide the work into different visual areas. Children use baselines to divide the area of ground and sky. The ground element in the drawing is the supporting area to make the objects placed in a stable condition. The ground element is also the ground plane of work. The sky element represents the facade of the work. The ground plane and the facade compose the three-dimensional visual space of the work. The comparison features of objects in works that accurately represent the baseline are more evident than in works of others baseline types (Table 4.). Although more works without a baseline type show the distance comparison features than in the other two baseline types of works, children who did not draw a baseline were weak in expressing both the distance and proportion features of objects in their works. This result shows

TABLE 4 Percentages between different baseline types and comparison types.

| Items | Without baseline | Objects placed on the baseline | Baseline divided the drawing areas |
|---|---|---|---|
| Without or wrong comparison | 11.8 | 18.5 | 8.1 |
| Proportion comparison | 37.2 | 49.8 | 17.4 |
| Distance comparison | 40.7 | 23.8 | 35.2 |
| Distance and proportion comparison | 10.3 | 7.8 | 39.3 |

TABLE 5 Variance analysis between gender, age group and baseline.

| Items | | Baseline % | | | Total % | $\chi^2$ | *p*-value |
|---|---|---|---|---|---|---|---|
| | | Without baseline | Objects placed on the baseline | Baseline divided the drawing areas | | | |
| Gender % | Boys | 35.65 | 28.90 | 35.44 | 47.4 | 7.236 | 0.027* |
| | Girls | 43.54 | 27.38 | 29.09 | 52.6 | | |
| Total % | | 39.80 | 28.10 | 32.10 | 100 | | |
| Age % | 7–8 years old | 37.59 | 39.36 | 23.05 | 28.2 | 35.283 | 0.000** |
| | 9–10 years old | 36.43 | 24.87 | 38.69 | 39.8 | | |
| | 11–12 years old | 45.94 | 22.19 | 28.10 | 32 | | |
| Total % | | 39.80 | 28.10 | 32.10 | 100 | | |

*$p < 0.05$; **$p < 0.01$.

that children who did not draw a baseline have limited cognition in expressing the comparison features in work. The distance comparison feature determines the spatial depth of the work. The proportion relationship determines the shape features of objects. Most of the children who did not draw a baseline only show one comparison feature of the proportion and distance comparison features (Table 4.). This result shows that the ability of these children to organize the visual–spatial relationship of the complete entire drawing still needs to improve. Drawings without a baseline mean that the objects and figures in work lack the ground that supports them to keep stable visual conditions. The visual effect of these drawings may show all objects being suspended in the air. Combining the results of Table 3 and the rules of painting creation practice shows that works with baseline have more obvious three-dimensional spatial effects than works without baseline. Besides, the statistical results of all children's works show that most works do not display baseline features (Table 4.). Thus, it is difficult for most children to represent three-dimensional space in their drawings.

Age, gender, and baseline features were categorical data (Ahi, 2017). For this reason, age-related and gender-related differences in children's performance of baseline features were calculated using the Pearson Chi-squared test. Children of different genders and age showed significant differences in the baseline features of their works. The results ($\chi^2 = 7.236$, $p = 0.027 < 0.05$) showed a significant difference in the baseline performance of different genders of children in the works (Table 5.). Comparing the percentage results of boys and girls showing baseline features in the drawings showed that more girls than boys did not draw baselines. Also, more boys than girls drew the other two types of baseline features. Thus, the above results show that boys are better than girls at expressing baseline features. At the same time, the three-dimensional spatial features of boys' drawings are more evident than those of girls. Objects placed on the baseline mean that the child can divide the drawing area of the work, but the location description of the baseline is not accurate. The baseline divided by the drawing areas represents the child can separate the drawing area and draw the correct position of the baseline. Comparing these two types of baseline statistic results shows that more children accurately drew the baseline location than those who did not accurately draw the baseline. This result indicates that most of the children can accurately delineate the regional features of the ground and sky by using a baseline.

The results ($\chi^2 = 35.283$, $p = 0.000 < 0.01$) showed that children of different age have differences in performing baseline features (Table 5). Comparing the percentages of the three age groups showed that children between ages 9 and 10 years performed better at baseline than the other two groups (Table 5). Most children between ages 7 and 8 years draw objects on the baseline. Only a few children can express baseline accurately. These two results indicate that children aged 7–8 years can use the baseline to divide the space between the ground and the sky of the work. However, their ability to express baseline features still requires further training. Most children aged 9–10 years can accurately draw baselines. Children aged 9–10 years drew objects on the baseline were the fewest. Therefore, children between ages 9 and 10 years can accurately represent baseline features. The number of drawings without a baseline was higher in the pseudorealism stage than in the other two drawing stages. This result indicates that children in this stage need to train their ability to express baseline features.

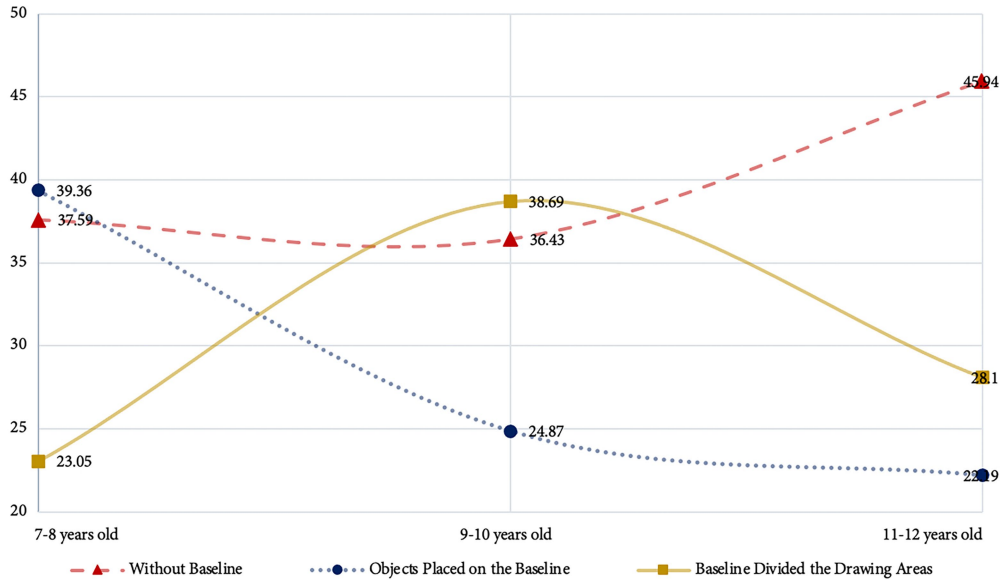



FIGURE 1
Trend chart in baseline features at different age stages.

TABLE 6 Variance analysis between age stages and comparison.

| Features | Types of comparison | Age % | | | Total % | $\chi^2$ | *p*-value |
|---|---|---|---|---|---|---|---|
| | | 7–8 years old | 9–10 years old | 11–12 years old | | | |
| Comparison % | Without or Wrong Comparison | 48.23 | 30.40 | 31.56 | 35.80 | 36.991 | 0.000** |
| | Proportion Comparison | 33.33 | 33.42 | 36.56 | 34.40 | | |
| | Distance Comparison | 6.38 | 14.32 | 10.63 | 10.90 | | |
| | Distance and Proportion Comparison | 12.06 | 21.86 | 21.25 | 18.90 | | |
| Total | | 28.2 | 39.8 | 32 | 100 | | |

**$p < 0.01$.

The number of children aged 9–10 years old who did not express baseline features was less than the number of children aged 7–8 years old. This result suggests that children aged 9–10 years old have better at performing baseline than children aged 7–8 years old. There is a clear increasing trend in the number of children who do not draw a baseline during children between ages 11 and 12 years (Figure 1). This part of the data indicates that children between ages 11 and 12 years have a lower ability to draw baseline than those children aged 9–10 years old. Moreover, the number of children aged 11–12 who did not display baseline in drawings is more than the number of children aged 7–8 years old. Thus, the baseline performance ability of some children after 10 years old will show a downward trend with the increase of children's age.

Age-related differences in children's performance of comparison features were calculated using the Pearson Chi-squared test. Children of different age showed significant differences ($\chi^2 = 36.991$, $p = 0.000 < 0.01$) in the performance of comparison relationship between objects in drawings (Table 6). Most children have a weak ability to express the comparison features in the works. 34.4% of the children showed the proportional comparison features in drawings (Table 6). For children who can paint the comparison features, their ability to draw proportional comparison features is higher than that of distance comparison features. Also, only 18.9% of the children can express both distance and proportion features in their works (Table 6). The proportional relationships in the drawing are related to the width and height of the object. Length and width compose the effect of the two-dimensional space of the drawing. The distance relationship between objects constitutes the effect of the three-dimensional space of the work. The distance relationship between objects also represents the depth of field of the drawing. Therefore, the results of the comparison features indicate that children of all ages have a weaker ability to express the distance comparison feature in the drawing. This result also shows that children's ability to represent works in three-dimensional space is weak.

48.23% of the children between ages 7 and 8 years do not present or present the wrong comparison features (Table 6.). In the works showing the comparison features, 33.33% of the children

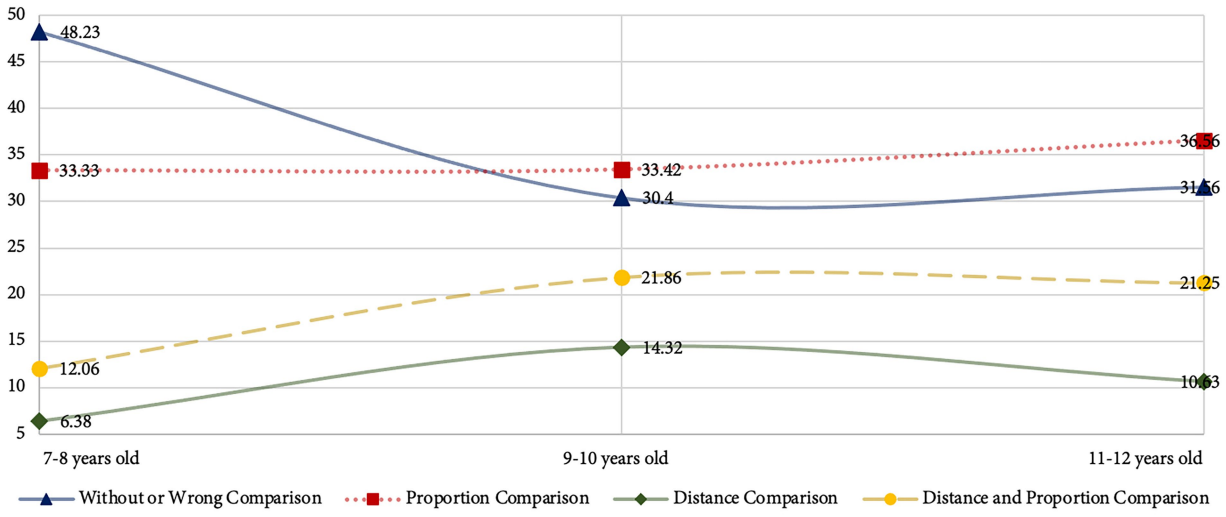



FIGURE 2
Trend chart in comparison features at different age stages.

between ages 7 and 8 years can indicate the proportional comparison relationship between objects (Table 6). Only 6.38% of children can show the distance comparison features between objects (Table 6). Thus, it shows that most children between ages 7 and 8 years have difficulty expressing the size and distance relationship of objects. Children aged 7–8 years old who can represent the comparison feature of objects have difficulty representing the distance comparison features of objects. Children aged 9–10 years old with the highest performance accuracy compared to the three age groups. Also, the number of children who displayed both distance and proportion features at aged 9–10 years old was higher than in the other age group. Therefore, children between ages 9 and 10 years with better performance among the three age groups.

The results of comparison features of the drawings in the three age stages show that children's ability to express distant comparison increases with age from 7 to 8 years old stage to the 9–10 years old stage (Figure 2). There is a decreasing trend in children's ability to express distant comparison features from the 9–10 years old stage to the 11–12 years old stage (Figure 2). The ability to draw proportional comparisons improves with the age of the children. Among the works that display comparison features, the most frequent feature shown by children is the proportional feature. The distance and proportional relationship between objects represent the spatial visual effect of the work. The distance comparison and volume of the objects compose the depth of the drawing. The proportional feature constitutes the relationship between the size of the objects and the plane effect of the drawing works.

The combination of these aspects shows that children capable of expressing comparison features can better draw the size relationship of objects and the overall plane effect of the drawing works. However, they have a weak ability to paint the volume of objects and the three-dimensional space of drawings. Thus, children aged 7–12 can represent proportional comparison features. Children need to learn and practice the expressing method of distance comparison.

## Discussion

Most children use the front view to create their drawings in terms of observation perspective. This result may be related to their observing and creative habits. The front view drawing is what observers perceive by the front of objects and figures (Rose and Jolley, 2020 and Lindstrom, 2021). This result shows that most children are more familiar with the frontal appearance features of objects and figures. The contents of children's drawings are related to the things children observed (Wright, 2014; Latham and Ewing, 2018; Metin and Aral, 2020). Therefore, children's observation habit is from the front of objects and figures to observe. Only a minority of children use other observational perspectives in their works. This result is because children have less creative experience in several types of observational perspectives. The participants' first grade mathematics textbooks included related lessons to guide children in identifying different viewing perspectives (Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). As a consequence, the participants in this test had the capacity to identify the types of observational perspectives. However, according to the analysis result the observation view show these children were less able to apply their knowledge from the mathematics curriculum to their drawing practice. The results of the observation view also showed that the small number of children's drawings contained more than one type of view. The presence of mixed views may also result in children paying attention to the visual features of objects and

figures (Goodnow, 2013; Yurumezoglu and Oztas Cin, 2019). However, children do not know methods to unify the different observation views of objects in their works. Therefore, in children's painting creation education, teachers should guide children to observe the appearance features of objects from different observation views. Long-term observation training can help children distinguish the shape features of objects under different observation views and methods of drawing expression.

As for the baseline performance, there was an upward trend in the baseline performance ability of children from 7 to 10 years old. When children reach 11–12 years old stage, their baseline performance ability trend downward. This result may related to the habit of children's drawing practice. Because children pay too much attention to the effects of painting creation, they may ignore the problems of painting skills in the painting process. The children who participated in the test had already learnt to judge the position and order of objects in their year 1 mathematics curriculum (Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). However, they neglected to represent the skills they had learned in the mathematics curriculum in their work. When children accomplish the works, they may classify the creative experience as a successful creative experience. They may keep repeating the form of painting they think is correct. Children in this situation may repeatedly show weaknesses in their compositional and stylistic skills in the pieces. At the same time, children are unaware of the problems with drawing. Children's drawing abilities such as composition, sketching, and color perception may not be improved by continuous painting practice. The results based on the baseline and comparisons in this study also demonstrate the problems of children's drawing practice. The developmental stage of children's drawing is from the 7–8 years old stage to the 9–10 years old stage. The visual effects of 9–10 years old children's drawings show a decreasing trend due to the limitations of drawing ability and cognitive development level (Figure 1). Therefore, for children in the schematic and dawning realism stages, it is more important to help children develop the ability to identify problems in their drawings than continually complete their works.

As for the performance of comparison features, the fewest display comparison features in children's drawings is distance comparison. Children's drawing ability, observation ability, drawing habits, and spatial perception ability are the reasons that display minor distance comparison features in their works. The expression of distance comparison features in paintings is related to children's cognition of positional (Mix, 2019). The performance of the distance comparison features in the drawings is connected to the children's understanding of the concepts of occlusion relationship and proportional comparison relationship (Chu et al., 2018). The formation of the occlusion relationship is due to the existence of a front-to-back position relationship between two objects. Moreover, the object near the observer partially occludes the thing far from the observer. Comparison of proportions is related to the relationship between the distance and position of the objects. Objects that are far from the observer are smaller than objects that are close to the observer. The appearance of occlusions and distance comparisons are related to children's drawing abilities. Children with well-drawing skills may focus on the location and proportions of objects. However, children with limited drawing ability may neglect to draw the proportional and positional features of the things. Thus, children's drawing ability may become one factor that influences their ability to express the distance comparison feature. The appearance of objects depends on children's observation of natural and living scenes. It is difficult for some children who have not received drawing training to create works using professional drawing techniques and perspective principles. This part of children will only develop drawings by observing objects in nature and life scenes. The children's observation ability will determine the visual effect of their works. Children with a high level of observation ability can pay attention to changes in the proportions and shapes of objects from different viewing perspectives. However, children with weaker observation skills may ignore changes in the shape and characteristics of objects. Hence, the expression of distant comparison features is relevant to children's observation ability. Some of the children who relied on imagination to create their works showed distant comparison features that probably related to their drawing habits. The drawings created by imagination lack the process of observing life scenes. The creative process of these children may consist of repeating their familiar drawing experiences. Children may not characterize objects according to drawing rules or real-life scenarios. These children also cannot draw distant comparison features. As a result, the painting habit will become a factor that restricts these children's performance of distant comparison features. Furthermore, the proportional features of objects presented in children's drawings are related to their quantity sense (Odic, 2018). This sensory ability develops as children visually estimate objects' width, height, and volume. Children's ability to assess objects' quality is associated with mathematical learning (Atit et al., 2021). The participants also had volume sense and physical sense training in their second-grade mathematics curriculum (Research Group of National Mathematics Curriculum Standards for Compulsory Education, 2013). These children may have grasped methods of rough estimating the volume and physical features of objects. However, children's ability to accurately assess the height, width, and depth features of objects requires further training.

## Conclusion

This study assesses children's drawing based on viewing perspective, baseline, and comparison features. The observation perspective that children most apply is the front view. The result indicates that most children have the highest awareness of the spatial characteristics of the front of the object. Therefore, in the practice teaching of painting to children aged 7–12, art teachers should guide children to analyze the changes in visual

characteristics of objects from different viewing angles (such as changes in length, width, height, and volume under different viewing angles) and position and position changes in features (such as occlusions between objects, changes in positional relationships such as neighbors and distances). Fine arts teachers also need to guide children to observe the changes in the shape and spatial from different viewing perspectives. In addition, teachers need to guide children not only limited in identifying different viewing perspectives of objects but also in analyzing changes in the contour features of objects from different viewing perspectives.

The appearance of baseline features shows that more than half of the children between the ages of 7 and 12 have the sense to show baseline features. This result also indicates that children have cognition of dividing the visual space area of the drawing and expressing the ground plane. Although more than half of the children were conscious of the baseline characteristics, children drew objects on the baseline. Therefore, children's ability to accurately perform baseline performance still needs to be trained. The performance of baseline correlated with children's ability to represent visuospatial regions. Therefore, the premise of baseline feature performance is to guide children to use the location features of different objects to paint the regional elements of the sky and the ground. For example, the location features of elements such as clouds, sun, moon, and birds represent the regional features of the sky. Use the location elements such as plants, houses, and people to express the regional characteristics of the ground. At the same time, fine arts teachers can guide children to identify the position of the apparent horizon and horizon in real-life scenes. The horizon is the mark that divides the sky and ground areas in the drawing. The position of the apparent horizon determines the viewing angle of a person. If children display the position features of apparent horizon and horizon, they are likely to accurately characterize areas of the ground and sky in their drawings. Therefore, the position training of observing the horizon and eye level is an effective method to improve the characteristics of different visual areas of children's performance works.

Children's ability to draw distant comparison features remains to be improved. The proportional features between objects are related to the length and width features of the objects. It indicates that children have well able to express the length and width features of objects. The comparison of distant features in the drawing relates to expressing the spatial depth of the volumetric features. The children aged 7–12 can display the visual effects of objects in a flat. However, the ability of these children to express the three-dimensional visual effect of works still needs further training. The key to improving three-dimensional visual space ability is to establish children's cognition of the volume of objects and the cognition of position. When guiding children's drawing practice, fine arts teachers need to provide children with the methods of visualizing objects' contour and volume features. For instance, fine arts teachers can assist children in achieving their ability to visualize contour features by observing the length and width features of objects. Children's ability to represent volumetric features can be facilitated by directing their attention to the height and depth of the object in space. Meanwhile, teachers need to instruct children to observe the changes in the contours and volume features of the objects with different position relationships. Therefore, the development of the ability to express comparison features achieves by training children's ability to draw the volumetric and positional features of objects in their drawings.

The above results indicate that children's awareness of applying interdisciplinary knowledge in practical drawing creation activities is weak. Children have only grasped the estimation methods in the mathematics curriculum related to estimating the features of length, width, and volume of objects. However, children's ability to represent the geometric features from visual assessment in their drawings still needs to be improved. Teachers need to guide children to observe the features of objects in real-life situations. Some teachers may only use images to teach children to estimate the geometric characteristics of objects. As a result, children will be unable to accurately understand the width, height, and volume of objects in real-life scenes. Therefore instructing children to observe the geometric and spatial features of objects in real-life situations needs to be actually integrated into the fine arts curriculum.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by Beijing Normal University Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## Author contributions

LY contributed to the conceptualization, methodology, formal analysis, investigation, data curation, and draft writing. YL is responsible for reviewing and editing the article. All authors contributed to the article and approved the submitted version.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 21 October 2022
DOI 10.3389/fpsyg.2022.1008372



OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

RECEIVED 31 July 2022
ACCEPTED 27 September 2022
PUBLISHED 21 October 2022

CITATION
Yang T and Hong X (2022) Early childhood teachers' professional learning about ICT implementation in kindergarten curriculum: A qualitative exploratory study in China. *Front. Psychol.* 13:1008372. doi: 10.3389/fpsyg.2022.1008372



# Early childhood teachers' professional learning about ICT implementation in kindergarten curriculum: A qualitative exploratory study in China

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Many teachers have begun to adopt information and communication technologies (ICT) in early childhood education (ECE) settings to support children's learning. However, research shows that ECE teachers' ICT implementation practice is not always appropriate, and their limited professional learning opportunities is one reason for this. Researchers worldwide have called for more understanding of professional learning that supports ECE teachers' use of ICT in the kindergarten curriculum. In China, although ECE teachers' ICT competencies and skills are required in national documents, little has been reported about how they are supported in learning about implementing ICT in the current curriculum. Drawing on the Technological Pedagogical Content Knowledge (TPACK) model, this study investigates how a small group of ECE teachers in China have experienced professional learning regarding ICT-related curriculum. By conducting individual interviews and analyzing public and teachers' personal documents, this study finds that teacher participants had received diverse types of professional learning opportunities related to ICT implementation. These opportunities were provided by different organizations; however, one shared feature was a focus on the technical level of how to use ICT devices. This study also discusses the teaching-research culture underpinning participants' professional learning. This article provides significant implications for advancing current professional learning programs.

KEYWORDS

**early childhood teachers, professional learning, professional development, TPACK, China, kindergarten curriculum, preschool education**

## Introduction

There is ample empirical evidence showing that information and communication technologies (ICT) are implemented in early childhood education (ECE) settings all over the world (Gibbons, 2010; Dong, 2014). Correspondingly, the ICT-supported curriculum has appeared in some ECE settings, as teachers implement ICT to transform practices to

help children gain more learning and play experiences, and their ultimate goal is to support children's learning in this digital era (Nikolopoulou and Gialamas, 2015; Mertala, 2019).

However, previous researchers have indicated that training programs related to ICT-related curriculum are insufficient and inefficient for ECE teachers (Nikolopoulou and Gialamas, 2015; Blackwell et al., 2016), which might prevent teachers from appropriately using ICT in their kindergarten curriculum. Researchers in China have reported similar findings (Dong, 2014; Liu, 2017), but they seemed to provide overall descriptions without giving detailed explanations about the types and forms of professional learning opportunities that China's ECE teachers experienced.

Thus, research needs to unpack more specifically what types of professional learning opportunities teachers have had and how those professional learning opportunities support ICT-related curriculum in kindergartens. This study aims to investigate the ways in which ECE teachers in China have experienced those professional learning opportunities. Obtaining such understanding is timely and important, as the literature on this research topic has been focused on Western societies, and the Asian and Chinese contexts remain under-researched. The findings will provide empirical evidence and highlight issues existing in teachers' professional development regarding ICT implementation, which can contribute to the current knowledge base in this field and shed light on future professional development programs and policy-making.

## ICT implementation by ECE teachers

The importance of teachers developing ICT expertise has been noted by both international and national researchers (Dong, 2014; Blackwell et al., 2016; Johnston et al., 2020). Although the role that ICT plays in children's development is still debated, researchers have generally agreed that the current focus should be related to the question of *in what ways* should ICT be used to maximize its benefits, rather than *whether* ICT affects children's development (Blackwell et al., 2016; Bird, 2018). Ihmeideh and Al-Maadadi (2018) also have emphasized that the responsibility of integrating ICT into ECE settings falls on the shoulders of teachers. Therefore, the question how children use ICT with the guidance and support of teachers' is important for ECE settings. However, there is ample evidence showing that ECE teachers implement ICT for children in an inappropriate manner, such as providing insufficient responsive guidance and limiting children's interactions with ICT (Dong, 2014; Sargent, 2017). Inappropriate ICT implementation may cause children to have negative feelings and limited learning opportunities, which may have a long-term effect on children's ICT-supported learning (Dong, 2014; Park, 2015). Given that teachers are the ones who decide how children experience ICT in ECE settings, their professional learning experience regarding ICT-related curriculum is an important research topic.

Researchers have drawn teachers' attention to teachers' professional development as it relates to ICT competence, identifying teacher training as the main factor influencing their practice (Blackwell et al., 2016; Sargent, 2017; Dardanou and Kofoed, 2019). For instance, in Norway, Dardanou and Kofoed (2019) have reported that teachers lack knowledge about how to deal with ethical issues regarding ICT implementation due to the absence of relevant training, in Jordan, Ihmeideh (2009) found that ECE teachers lack funding to participate in ICT-related training and therefore stick to old approaches to teaching, and in Greece, Nikolopoulou and Gialamas (2015) reported that ECE teachers had more training opportunities on the technical level than the pedagogical level and indicated that their previous training did not enhance their confidence with ICT implementation. However, previous researchers simply described teachers' ICT-related training without specifically investigating the ways in which they experienced those training opportunities.

Research shows that ECE teachers' training experience in ICT implementation can effectively enhance teachers' motivation to ICT use and develop knowledge about how to support children's learning in appropriate ways. Ihmeideh and Al-Maadadi (2018) provided an intervention training program (that focused on teachers' understanding of ICT itself, ICT-related teaching strategies, and examples of effective ICT implementation practices) for ECE teachers in Qatar, and found that teachers tended to experience a careful decision-making process when about to implement ICT in learning activities after the training. In Australia, after examining a professional learning approach (i.e., practitioner inquiry) adopted to facilitate ICT implementation in ECE settings, Johnston et al. (2020) reported the value of individual and collaborative group reflections and the significance of various professional learning resources (such as professional reading, group discussion and workshops). However, at present, the number of studies on how ECE teachers experience ICT-related professional development opportunities is still limited.

Albeit little empirical evidence regarding ECE teachers' professional learning experience relating to ICT implementation exists, researchers have provided suggestions to support ECE teachers' practices, such as emphasizing that training programs should be carefully designed to provide teachers with skills to evaluate appropriate devices or software (Nikolopoulou and Gialamas, 2015). Mertala (2019) suggested that ECE teachers should have more training opportunities that go beyond the focus on using ICT for teaching curricular subjects. Furthermore, Sargent (2017) advocated that ongoing support could help teachers experience sustainable changes in knowledge and skills related to ICT implementation. Researchers have argued that ECE teachers' observation and reflection on ICT use are important parts of professional development because the process of "observation, reflection, changes to practice and more reflection" (Vidal-Hall et al., 2020, p. 176) can result in a modification of view, and therefore, a transformation in teaching practice, which finally influences children's learning experience. These studies are important for understanding how ECE teachers could be provided

with professional learning opportunities to support their ICT implementation.

In summary, there have been more and more calls for a focus on ECE teachers' professional learning in relation to ICT implementation in the curriculum, as the ICT-related curriculum provided by teachers has a profound influence on children's learning and development. Based on the research gaps discussed above, this study aims to gain an in-depth understanding of how ECE teachers have experienced professional learning with regard to ICT-related curriculum.

## TPACK model as a professional development framework

Teacher understanding of technologies is fundamental to their ICT implementation (Blackwell et al., 2016; Johnston et al., 2020). Some researchers have also argued that teacher understanding of pedagogies is critical, because it determines how teachers implement ICT in pedagogical activities (Nikolopoulou and Gialamas, 2015; Mertala, 2019; Vidal-Hall et al., 2020). These different understandings of the foundation of ICT implementation have resulted in multiple foci in relation to ICT-related professional development. As discussed above, some professional learning opportunities focus on the technical level while others emphasize teachers' reflections on the pedagogical level of ICT use. This study believes that teacher understanding of technologies and pedagogies are both important for their ICT implementation; therefore, this study adopts the Technological Pedagogical Content Knowledge (TPACK) model (Mishra and Koehler, 2006) as its theoretical framework.

The TPACK model is a framework for investigating teachers' instructional knowledge within the contemporary digital age (Mishra and Koehler, 2006). The foundation of the TPACK model is Shulman (1986) Pedagogical Content Knowledge (PCK), which has been regarded as a measure of the development of a teacher's knowledge regarding how to design specific pedagogical activities (Pedagogical Knowledge) that enhance the teaching of subject-related content (Content Knowledge). With the arrival of technologies in educational settings, Technological Knowledge (TK, a teacher's technology-related competence and skills) was regarded as another knowledge base by Mishra and Koehler (2006) to understand technology-supported teaching. There are interactions between different knowledge bases; Technological Pedagogical Knowledge (TPK) is the knowledge of the ways in which specific pedagogical practice can be facilitated by technology, and Technological Content Knowledge (TCK) is the understanding of how the subject matter can be combined with technology use. The TPACK model, therefore, refers to the repository of teacher understanding of how to use technology for specific pedagogical activities that enhance the teaching of specific subject matter (Mishra and Koehler, 2006).

The TPACK model has been widely regarded as a professional development framework for facilitating pedagogical practices with ICT. For example, researchers have introduced TPACK concepts to teachers, supported their pedagogical change (Koh, 2019), and used it as a model of professional learning to plan training that focuses on particular knowledge components (Angeli et al., 2016).

However, the relationships between TPACK components have been a debate among researchers, such as whether TPACK is a unique body of knowledge that helps to realize the transformation of knowledge or the integration of six single knowledge components (Angeli et al., 2016). This debate is significant because the actual relationships among knowledge components could explain whether training in relation to technology competence could effectively contribute to teachers' TPACK development.

Given that the TPACK model has the analytical power to unpack the complicated stories behind teachers' practices regarding ICT implementation (Park, 2015; Blackwell et al., 2016), this study adopts it as the theoretical framework for investigating Chinese ECE teachers' professional learning experiences, by using it to guide data collection and the interpretation of the findings this will be explained in section: The current study.

# The context of China

In the context of globalization, educational authorities in China have introduced educational ideas from other countries (such as cognitive constructionism by Piaget and social constructionism by Vygotsky) into China in recent decades. Correspondingly, the educational principles adopted in kindergartens have evolved from encouraging teacher-directed teaching strategies to promoting child-centered teaching strategies, and from emphasizing collectivism to paying attention to individuality (Rao et al., 2010). The education reform puts forward many new requirements for kindergarten teachers, such as a kindergarten-base curriculum, pedagogical strategies, the ability to observe children and reflect on teaching (Jiang et al., 2017), and competence in using ICT for teaching (Dong, 2014; Luo et al., 2021a). This section discusses the common professional learning opportunities for kindergarten teachers in China and explains why investigating their ICT-related professional learning is important.

## Professional learning opportunities in China

In China, *teaching-research activities*/教研活动 (Song et al., 2014) is a main approach to support teachers' curriculum-based professional learning. For an instance, the Jiangsu Provincial Department of Education (2017) indicates that to facilitate teachers' abilities for observing children's learning, teachers should conduct research on their own teaching. A common strategy for the teaching-research activities is *instructional viewing and emulating*/教学观摩. Kindergarten teachers participate in instructional viewing and emulating to construct pedagogical

knowledge and transform practice through learning from peers, reflecting on instruction and receiving feedback from others (Huang et al., 2019).

In China, teachers usually need to participate in "lesson polishing"/磨课 (Yang and Li, 2017, p. 15) to prepare for instructional viewing and emulating. This implies that they practice giving the same lesson several times with similar content and presentation. In this way, teachers who participate in lesson-polishing can ask for comments from their colleagues and other people (such as principals) to adapt his/her teaching based on the feedback received (Yang and Li, 2017). Despite the possibility that the activity can benefit teachers by fostering peer learning, exercising reflection skills, and gaining access to collective wisdom, this article argues that it might be less beneficial for children because they experience similar whole-class activities repeatedly (if a teacher does "lesson polishing" with the same classroom).

Aside from the above-mentioned teaching-research activities, researchers have reported that some Chinese educational authorities often organize teaching skill competitions (either at the local level or at the national level) and use awards as a means of encouraging teachers to improve their teaching skills (Nong and Zhao, 2012; Song et al., 2014; Lu and Liang, 2016). Zhang and Ng (2011) investigated teacher appraisals in secondary schools in Shanghai and found that teachers' rationales for participation are related to personal growth and honor; the honor could be given both personally and at the school level since individual winners can get awards, and their schools can gain the reputation and glory. By interpreting this phenomenon through Chinese traditional culture (i.e., collectivist ideology), Zhang and Ng (2011) indicated that teachers who participate in competitions are expected to work as a member of the collaborative group who can make contributions by bringing honor to the group.

This section has briefly introduced Chinese teachers' professional learning opportunities, particularly the teaching-research activity. Those activities should be interpreted within the Chinese context; for example, a few possible reasons for lesson-polishing include the Confucian culture, which emphasizes self-improvement and drilling (Rao et al., 2010), and collectivist ideology, which stresses the power of collective actions (Zhu, 2011). These professional learning opportunities may have important roles to play in influencing ICT implementation in the ECE curriculum, but there has been little empirical evidence at present.

## ICT implementation in ECE contexts in China

The Ministry of Education of China (2012a) issued *10-Year Development Plan for Education Informatization (2011–2020)* and listed the construction of an ICT-supported learning environment within all educational contexts (including ECE) as a national development goal. Teachers' integration of ICT in teaching and student-centered pedagogies as a means of catering to students' different learning needs and interests is also encouraged by the plan. In the past decade, educational institutions at different levels (including kindergartens) have invested in their ICT infrastructure in terms of the amounts and types of devices (Luo et al., 2021a). Additionally, there have been new requirements for teachers' ICT competence and understanding of how to use ICT to transform pedagogies.

The new requirements are revealed in some national documents. For example, the *Professional Standards for Kindergarten Teachers (Trial Version)* (Ministry of Education of China, 2011a) requires kindergarten teachers to possess a broad range of knowledge and skills, including knowledge related to ICT: "基本要求: 具有一定的现代信息技术知识。[Basic requirement for kindergarten teachers: Have enough knowledge about modern information technology.]" (Ministry of Education of China, 2011a, p. 13). In another document, *Teacher Education Curriculum Standard (Trial Version)* (Ministry of Education of China, 2011b), pre-service kindergarten teachers are expected to attend a course focusing on the application of modern educational technologies. These evidence demonstrate that kindergarten teachers are expected to gain ICT skills for teaching. However, those requirements are not always explicit and teachers may interpret questions like "what type of ICT implementation is expected" and "how ICT should be used in teaching" in different ways, which would further shape their actual implementation practices.

Few researchers have reported the current state of teachers' professional learning in relation to ICT implementation in kindergartens in China, noting that the teachers have generally received technology skills training (Dong, 2014; Liu, 2017) while training related to how to use ICT for better pedagogies is lacking. By reviewing several empirical studies on the current situation of ICT implementation in ECE in China, Luo et al. (2021b) have argued that ICT-related training should meet teacher demands and be relevant to the pedagogical aspect of ICT implementation. Previous researchers have attributed the inappropriate use of ICT to a lack of training opportunities (Dong, 2014; Liu, 2017). Given that the training opportunities may influence how teachers combine ICT with the kindergarten curriculum and then profoundly influence children's development, it is important to gain an in-depth understanding of the current state of ICT-related professional development in the ECE context in China.

# The current study

## Research design

Chinese educational authorities have made efforts to support teachers' learning of advocated educational ideas by supervising teaching-research activities and organizing teacher competitions. However, researchers have argued that many teachers are still

struggling to put those ideas into practice (Jiang et al., 2017). This issue may also happen to their practices about ICT implementation and relevant curriculum. Although the implementation of ICT in teaching and learning has been listed in China's national development guidelines, little has been reported about how kindergarten teachers are supported in learning about ICT implementation. Therefore, this article aims to address the following research question: In what ways have teachers experienced professional learning opportunities in relation to ICT implementation in kindergartens in China? Drawing on the TPACK model, the findings can also demonstrate in what ways these ICT-related professional learning activities influence teachers' ICT implementation in teaching practices.

This article reports on part of a doctoral research project that explored kindergarten teachers' ICT-related perceptions, practices and professional learning experiences (Yang, 2021). The study is based on interpretivism (a research paradigm that believes multiple realities exist and are relative to individuals who have "particular sense-making, constructions, or meanings', see Lincoln and Guba, 2013, p. 46) and it adopts a qualitative research design to gain an in-depth understanding of how teachers interpret and ascribe meaning to their experiences relating to ICT implementation. This article discusses teacher participants' ICT-related professional learning experiences in particular.

The research design of the study draws on the theoretical framework, the TPACK model. This is because the TPACK model emphasizes individual teachers' personal experiences and their own construction of knowledge related to technology, pedagogy, and content (Mishra and Koehler, 2006). Based on the research objective, it is important for the current study to consider teachers' TPACK when investigating their personal interpretations of, and experiences related to, ICT-related training. Therefore, the interpretive qualitative research design was adopted to investigate teachers' perceptions and experiences in-depth.

## Contexts and participants

The setting of this research is located in an eastern city with well-developed educational resources and socio-economically advantaged development (Ministry of Education of China, 2012b). To select information-rich cases to address the research questions (Patton, 2015), this study purposefully selected kindergartens that are equipped with various types of ICT devices. Based on different types and ranks, three kindergartens were selected: River Kindergarten is government-funded, Lake Kindergarten is university-funded, and Stream Kindergarten is self-financed. Furthermore, River Kindergarten is an ICT-exemplary kindergarten, which means it has a reputation in terms of an ICT-supported curriculum. Furthermore, this study purposefully selected teachers based on two criteria: they should have at least 10 year of experience in implementing ICT, and they should differ in terms of ages, educational backgrounds, teaching experiences and qualifications. Fifteen teachers were recruited for the study.

Among the participants, two were from the Lower Class (serving children aged 3–4 years old), five were from the Middle Class (serving children aged 4–5 years old) and eight were from the Upper Class (serving children aged 5–6 years old). Nine participants were in their 20s, with 1 to 5 years of teaching experience; the rest of the participants were in their 30s, with generally over 10 years of teaching experience. For educational backgrounds, 11 participants had a bachelor's degree and four participants had vocational college diplomas. All participants gave informed consent for the research. In this article, the names of teachers and kindergartens are pseudonyms used to enhance confidentiality. This study has gone through strict ethical review by the University of Auckland Human Participants Ethics Committee.

## Data collection and analysis

To answer the research question, this study needs to understand how teachers have experienced professional learning in relation to ICT implementation and how they ascribe meanings to those experiences. Therefore, individual interview was adopted for its value in accessing teacher perception and experience. The interview protocol focuses on questions such as what types of training they had received in relation to ICT implementation and in what ways they thought the training was valuable or not. Based on the TPACK model, the interview protocol also focused on questions regarding technological and pedagogical aspects of participants' perceptions and training experiences. The format of individual interview was semi-structured, which allowed the researcher to further investigate the meaning behind participants' narratives. The researcher often prompted participants' responses related to TPACK components (such as in what ways their technological pedagogical knowledge was developed *via* a professional learning activity) to address the research question. With the participants' permission, all interviews were recorded for data analysis.

Document analysis was another research method used in the investigation, as it can help the researcher gain contextual information and develop topic-related knowledge (Merriam, 1998). In this study, public documents and private documents were included in the analysis to understand the research topic. In particular, public documents included national documents and guidelines, and websites of national or local competitions among teachers, such as *Professional Standards for Kindergarten Teachers (Trial Version)* (Ministry of Education of China, 2011a) and *Teacher Education Curriculum Standard (Trial Version)* (Ministry of Education of China, 2011b). This type of document can be valuable for investigating educational authorities' expectations for teachers' competence and professional learning, including those regarding ICT implementation. Meanwhile, teachers' personal documents, such as teaching plans for instructional viewing and emulating and training notes, were collected to further understand their actual practice and training experiences. More importantly, the document analysis also offered an

opportunity to triangulate the interview data (Patton, 2015); the alignments and misalignments between documents and teacher narratives can reflect what the policy-practice gap looks like, and the reasons for the gap can shed light on the analysis of data.

The study adopted thematic analysis to investigate patterns and themes in collected information (Patton, 2015). The data analysis included the following steps. First, the researcher transcribed and translated (from Chinese to English) all interview recordings and read and re-read collected documents for familiarity. Then, the researcher searched for recurring elements and analyzed the transcripts and documents both inductively (i.e., keeping an open mind for frequent units that appeared in the data) and deductively (i.e., being influenced by some pre-determined topics, such as TPACK components). Next, the researcher considered how different codes would combine to form a theme or sub-theme. For example, the codes "learning new approaches to implementing ICT" and "seeing the potentials of ICT use" were combined into a sub-theme: "The perceived benefits of visiting other kindergartens." After doing so, the researcher continued to investigate the relationships between themes and sub-themes. For instance, the sub-themes "the perceived benefits of visiting other kindergartens" and "teachers" preparation for holding visits' worked together in telling a holistic story related to the theme "visits as a professional learning approach."

In addition to the inductive analysis approach, this study also adopted a deductive method by using the TPACK model to guide this process. For example, the researcher intentionally searched for participants' TK, PK, TPK, and TCK in their narratives about ICT implementation and previous training. These knowledge bases were developed into various themes, working with other themes to tell a whole story about participants' training experiences. The relationships between different knowledge components were also identified (for example, the connections between TK, PK and TPK), which helped the researcher group and organize the sub-themes and themes. This process can also shed light on how professional learning on a single knowledge base could contribute to overall ICT implementation. In summary, the interpretation of interview data was based on the meanings of themes as well as the connections between themes and sub-themes.

The analysis of collected documents was mainly based on a deductive approach, as the researcher purposefully searched for information about the macro-level requirement or expectations related to teachers' ICT implementation, ICT competence, and professional learning. These aspects were included in the analytical category to examine the data and address the research question.

## Findings and discussion

This study found participants have received diverse types of professional learning opportunities in relation to ICT implementation, including kindergarten-based training, professional learning opportunities provided by the local education bureau and other teaching-research activities (e.g., *lessons for viewing*/公开课and *visiting other kindergartens*/参观). Three themes emerged from participants' narratives regarding ICT-related professional development and collected documents: *ICT-related training and technical support; visits and lessons for viewing*; and *competitions for teachers*.

### ICT-related training and technical support

The analysis found that participants have experienced three types of ICT-related training, which were developed as three sub-themes for explaining the collected data. The three types are: *pre-and in-service training that focused on ICT-operating skills*, *training provided by the local school district which involved teachers from different educational contexts*, and *technical training organized by kindergartens*.

Firstly, this study found that ten teachers had attended compulsory courses on ICT during pre-service education, which helped them to learn how to use computers. Five teachers noted that they had not experienced ICT-related courses until they began to work in kindergartens. Tong (30 years old, Lake Kindergarten) described the courses meant to deliver knowledge and skills regarding common software, such as how to use PowerPoint to make animations. When asked about the value and usefulness of the courses, Xie (24 years old, Lake Kindergarten) and the other two participants indicated that "I learned something from it, because I did not know those functions before"; however, Xie also indicated that the courses might not be necessarily useful for her pedagogy because she did not find the opportunity to combine those functions with her teaching. Based on Xie's narratives, the content of those courses does not always match its actual value in teaching practice. The review of collected documents (*Teacher Education Curriculum Standard* in particular) found that the description of the learning content for kindergarten teachers' ICT implementation is extremely vague, with no explicit explanation or requirement regarding in what ways teachers should implement ICT in practice.

In addition to courses, some participants have also joined an "ICT research team' organized by their local school district to learn ICT-relevant knowledge and skills. Dang (35 years old, Stream Kindergarten) indicated that members of the district-level research team, who came from different educational contexts (such as kindergartens and primary schools), had opportunities to discuss and share experiences in relation to how to adopt ICT as a teaching tool. Dang emphasized that she had learned from a primary school teacher how to make PowerPoint slides, such as how to insert pictures and videos. However, as previous researchers have noted (such as Dong, 2014; Ihmeideh and Al-Maadadi, 2018; Luo et al., 2021a), ICT implementation is highly contextualized, and this study argues that primary school teachers' knowledge about how to use ICT in teaching might not be appropriate for kindergarten teachers because of children's different age groups and different learning needs. The findings

demonstrate that, although a teaching-research team is believed useful for teachers to develop teaching skills and improve practice through exchanging experience and collaborating (Wang, 2015; Jiangsu Provincial Department of Education, 2017), the value of such professional development is dependent on whether teachers' knowledge and experiences can be appropriately and effectively transferred.

The third type of professional development identified in participants' narratives was kindergarten-based training. This kind of training was often provided when new ICT devices arrived at kindergartens. Eight participants described this type of training as "not frequent," indicating that it was mainly about "how to use the new hardware/software" with no instruction about "how to combine it with pedagogical activities" (Jing, 33 years old, River Kindergarten). In River Kindergarten, participants reported that the training sessions were organized based on the collaboration between kindergarten and ICT companies. Once the ICT device was introduced to the kindergarten and collaboration was established, the ICT companies would "set up their products in the kindergarten" and provide a training session on "how to use it" (Wan, 32 years old, River Kindergarten). Participants in the Stream Kindergarten also reported demonstration-focused training:

> When the interactive whiteboard was just implemented, the principals invited someone outside the kindergarten to teach us how to use this device. However, he only told us how to turn on and turn off the device. (Fan, 37 years old, Stream Kindergarten)

It seemed that this type of training was generally a "one-off experience" as they did not have following communications with the staff. Fan emphasized that "training is just training; how to use it [ICT] is all about teachers' decisions"; she explained that her ICT implementation was based on the teaching-and-learning goals. Given that ICT companies tended to provide one-off training with almost no attention to the pedagogical aspect, this study argues that this type of training might not directly contribute to appropriate ICT implementation. This finding is consistent with Vidal-Hall et al. (2020) and Luo et al. (2021a,b) who highlighted that training should be tailored to the needs of teachers and relative to the ECE pedagogies. More importantly, the importance of ongoing support for teachers' ICT implementation has been noted by Sargent (2017), who argues it can bring about sustainable changes in knowledge and skills. However, this feature was not found in participants' previous professional learning.

Analyzing based on the TPACK model, this study found that the technical training merely contributed to participants' TK rather than other knowledge components (such as TPK). The above-mentioned Fan's emphasis on the relationship between ICT implementation and the teaching-and-learning goals reflects that TPK should be a key focus during professional development to effectively prepare teachers for teaching in practice. In fact, nine teachers involved in this research believed that they had sufficient ICT competencies to implement ICT for daily teaching. Chinese kindergarten teachers generally utilized ICT as screen-based technologies in collective teaching (Dong, 2014; Liu, 2017) and this study argues that "sufficient" competence would not automatically contribute to their understanding of appropriate ICT implementation, for example, to support children's spontaneous exploration. Thus, this study argues that teacher knowledge about using ICT as a tool to support child-centric pedagogies should be an important part of their professional development. Previous researchers (e.g., Blackwell et al., 2016; Sargent, 2017) have identified a lack of training as the main barrier preventing teachers from implementing ICT effectively. However, this study found that participants had received ICT-related technical training from various organizations including kindergartens, ICT companies and local school districts. This is inconsistent with previous research such as Dong (2014) and Liu (2017), which found ICT-related training opportunities for Chinese kindergarten teachers were very limited. This mismatch perhaps implies that, Chinese kindergarten teachers' ICT-related training has received more attention in recent years due to educational authorities' increasing attention toward the development of educational technologies (see Luo et al., 2021a,b) Nevertheless, this study found that kindergarten teachers' ICT-related training was insufficient in terms of depth and scope because it tended to emphasize more on the technical level rather than the pedagogical level of ICT implementation. As previous researchers noted, understanding how to run a software program would not guarantee children's meaningful learning with ICT (Sargent, 2017; Mertala, 2019). To better enhance teachers' competence and skills for ICT implementation, more curriculum-based professional learning opportunities are needed.

## Visits and lessons for viewing

The second theme that emerged from participants' narratives and collected documents is *visits and lessons for viewing*. This study found that *instructional viewing and emulating*/教学观摩 was an approach used for teachers' curriculum-based professional learning, as participants had visited various kindergartens to learn about ICT implementation. This section discusses the findings based on two sub-themes: *how teachers perceive the values of visits and lessons for viewing*, and, *how teachers prepared for visits and lessons for viewing*, which work together in telling the story about participants' professional development from two distinguished perspectives.

How teachers perceive the values of visits and lessons for viewing reflects a complicated story. For example, Tong held a positive attitude toward *visit*/参观, a common means of instructional viewing and emulating activities, indicating she "can truly learn many things" through observing how other teachers implemented it in various subject-based activities. Another nine participants in the research shared this viewpoint. Tong, on the other hand, stated that while she "learned" about the potential of

ICT through visits, she did not put them into daily practice because of the belief that ICT implementation should be based on kindergartens' own curricula. This conclusion resonates with a study in Shenzhen (Huang et al., 2019), where researchers believed this form of professional learning was "low-quality" due to the disconnect between visits (i.e., viewing) and practice. Given the lack of attention on the pedagogical level, the present study contends that these activities are not practical enough for teachers. More practical guidelines and support, according to Huang et al. (2019), are needed to ensure the value of this type of professional learning.

Through a TPACK lens, the reasons why this form of professional learning is "low-quality" is two-folded. Firstly, while teachers' observation of others' ICT implementation is useful for developing their understanding of ICT, their TPACK might not be developed due to the lack of reflection. Vidal-Hall et al. (2020) have noted that teachers' observation and reflection are equally important because they work together in contributing to the modifications of perception and practice. TPACK has a heavy reliance on personal construction of different knowledge components and experiences of teaching in practice (Angeli et al., 2016; Koh, 2019), and therefore this type of professional learning might not develop teachers' TPACK to transform practice. More importantly, teachers' TPACK is highly contextualized and their practice is bound to kindergarten curricula, children's learning needs, and kindergarten-level cultures (Blackwell et al., 2016). Teachers' TPACK might not be smoothly transferred without consideration of these contextual factors. As for the second sub-theme, the other side of the story related to visits can be revealed from information gathered from River Kindergarten, an ICT-exemplary kindergarten. River Kindergarten often organized visits to allow teachers from other kindergartens to view and emulate ICT implementation. However, according to Lun (36 years old, River Kindergarten), the preparation phase included various tasks, such as cleaning, charging devices in advance, decorating the environment, and preparing *a lesson for viewing*/公开课. Those "lessons," as the kindergarten website shows, were generally about whole-class activities involving ICT-supported instruction. Xuan explained the preparation work for an ICT-supported lesson:

> For a 公开课 [the lesson for viewing], we need to write a teaching plan carefully, and practice it with children several times. Through conducting the teaching again and again, we can reflect on our practices and get feedback from experienced teachers in this kindergarten. Only in this way could we ensure a good result. (Xuan, 27 years old, River Kindergarten)

Xuan mentioned *lesson-polishing*/磨课 in describing her preparation, which is a common professional development approach used in diverse educational settings in China (Zhu, 2011; Yang and Li, 2017). However, as this practice means that similar teaching activities may happen several times, children may gain "repeated" or similar learning experiences by receiving fewer opportunities for active exploration. Therefore, this study argues that this format of professional learning is not appropriate for kindergartens because it works for the benefit of teachers rather than of the children. This reflects a long-held Chinese educational belief that teachers have a dominating position in educational settings because they possess the expertise required for knowledge-delivering (Rao et al., 2010). The findings reported in this section concern how teachers have experienced ICT-related visits as part of their professional development. The review of River Kindergarten's website found that the responsibilities of ICT-exemplary kindergarten include providing guidance to other kindergartens and promoting pedagogical interactions among kindergartens. Therefore, visits were described on the website as "teaching-research activities" aimed at promoting ICT implementation in other kindergartens. However, the value of this form of "teaching-research activities" needs further analysis and the data reflect a policy-practice gap. The analysis of collected documents found that Jiangsu Provincial Department of Education (2017) has provided suggestions about kindergarten teaching-research activities:

> … teachers should not sacrifice children's development, should not lead children to have activities in a performance format, should not train a group of children for their research work;
>
> … teachers should not organize research work which is out of children's playful context and out of kindergarten's daily activities … (p. 2)

The key point of this document is that teaching-research activities should not disrupt kindergarten normal activities. While Lun claimed that "it did not interrupt us because it's for the kindergarten development', the analysis of findings reflected the disruptions clearly. Being consistent with research in other education contexts in China (Wang, 2015; Lu and Liang, 2016), this study found that this type of professional development might influence children's development (by taking them out of the daily learning context), consume teachers' time and energy, and not always benefit visitors' practices. The suggestion from the study aligns with previous researcher's argument that "few teaching-research activities involve reflections about the actual value of these activities, [and] some [teaching-research] activities are not necessary but are conducted widely" (Wang, 2015, p. 62), calling for critical reflections on the value of teaching-research activities. These problems identified in the study, perhaps, are the reason why the Jiangsu Provincial Department of Education issued guidelines for kindergarten teaching-research activities.

## Competitions for teachers

As competitions among teachers have been considered an effective approach to assist professional development in China

(Nong and Zhao, 2012; Lu and Liang, 2016), the ICT-related competition was the third theme found in participant narratives and collected documents. Five participants mentioned ICT competitions held by educational authorities when asked whether they felt being encouraged to implement ICT in teaching; Wan (32 years old, River Kindergarten) strongly argued, "the competition itself is an encouragement, is not it?' It appeared that the general educational context has shaped the ECE context, making participants regard ICT implementation as an expectation of the educational authorities.

The competitions mentioned by participants included *Nanjing ICT-Supported Teaching Master Competition* (teaching master competition hereafter) and *Nanjing Micro-lesson Competition for Teachers in Primary and Secondary Schools* (micro-lesson competition hereafter). Those competitions required each participant to make a video of one lesson and send the recording to the local education bureau for evaluation. The evaluation criteria for the teaching master competition were collected (Nanjing Education Bureau, 2018), including: the design of ICT-supported teaching activities, teachers' proficiency with ICT skills, whether the implementation of ICT can effectively support teaching, and whether the effect of ICT-supported teaching is distinct from "traditional teaching." These criteria demonstrate that the aim of this competition is to encourage teachers to combine ICT with teaching appropriately. Through a TPACK lens, these competitions seem like an examination of teachers' TPACK and its application in teaching practice, however, this study argues that the competition may not holistically reflect teachers' TPACK because the teaching activity is short (explained later) and it does not happen in real kindergarten context.

This paper specifically discusses teacher experiences related to the micro-lesson competition because twelve participants were preparing for it during the data collection period. The collected documents (i.e., website for the micro-lesson competition) showed that this competition is also open to kindergarten teachers despite its title (i.e., for teachers in primary and secondary schools). The website also indicated that a micro-lesson is "a video-recording of a short, but complete teaching activity based on specific teaching content" (Nanjing Education Bureau, 2017, p. 2) and competition aimed at "improving teachers" pedagogical planning ability, contributing to the sharing of micro-lesson resources, and accelerating the reform of pedagogy' (p. 2). The micro-lesson competition targeted not only ICT-supported teaching but also wider teaching activities, and its aim that "accelerating the reform of pedagogy' can be supported by the implementation of ICT; thus, this study adopts the micro-lesson competition as an instance of three issues surrounding teacher competition.

The first issue is the disconnect between the micro-lessons designed only for the competition and teachers' normal practice. Qiong (24 years old, Lake Kindergarten) indicated that the aim of making micro-lesson recordings was merely "being involved in this competition." Qiong had played the micro-lesson recordings for children, but later realized that "children would not benefit from watching tutorial videos about folding papers; I think teachers' direct instruction is better" and began to doubt the educational value of those recordings. Qiong deduced that perhaps it [the micro-lesson] could benefit teachers if the recordings could be uploaded to a website for sharing with other teachers'. Qiong's assertion mirrored the data from document analysis, as the aim mentioned on the competition website is that the micro-lesson recordings are valuable resources for teachers to learn from others and reflect on their practices. Nevertheless, like other teaching-research activities, the aim of the competition was relative to teacher professional development (e.g., teaching competence and skills) rather than the development of the children. Thus, this study argues that while developing teachers' TPACK is important, it should not be aimed as an end in itself. The ultimate goal for developing teachers' TPACK should be closely related to children's learning and development.

The second issue is related to the amount of time needed to prepare for the competition. Wan indicated that she had to "plan the activity carefully, mock the activities several times, and edit the recordings' and therefore needed to spend much time on it. The review of the competition website also found that video-recordings should last for five to eight minutes and contain captions about the main steps of the activity. This procedure seems time-intensive. Participants' narratives reflected that while the competition was designed to encourage the sharing of educational materials to improve teaching abilities, it was time-consuming and ineffective in fact. Wan's narratives reflected that, again, participating in the competition requires teachers to repeatedly "mock" teaching activities, which may decrease children's opportunities for free play and spontaneous explorations.

The third issue that emerged from participants' narratives is about their choices in relation to competition participation. While Qiong and Wan doubted the value of micro-lessons, neither of them said no to the participation because they believed that "the principal hoped for our active engagement." While participants all used the word "voluntary" to describe their choice, they later noted they were "nominated" by principals and they hoped to meet principals' expectations. This shows that participation in ICT-related competitions was driven by top-down decisions and was disconnected from children's actual learning needs. This finding aligns with previous researchers' argument that structural hierarchies and making efforts to bring honor to a collective group are rooted in Chinese traditional culture (Zhang and Ng, 2011). In other education contexts such as secondary school education, it has been found that these beliefs have shaped the school culture in various ways (such as emphasizing individual teacher growth and contribution, see Zhang and Ng, 2011; Song et al., 2014). This phenomenon has also been found in the current study, which is in the context of kindergarten education. Being profoundly shaped by the social and cultural traditions, teachers' perceptions of competition and emphasis on group honor further influenced their choices and practices, according to the findings.

This section has reported how teacher competition, as a professional development approach, influenced teachers'

ICT-related practices. Based on the analysis of three issues regarding this professional development approach, this study argues that the competitions could occupy teachers' time and prevent them from investing time in planning meaningful activities. There has been no research into how teacher competition facilitates the development of TK, PK, and TPK, thus the usefulness of this form of professional development is still unknown. Additionally, the tensions experienced by participants deserve further investigation because they may also exist in other competitions, such as the ICT-supported teaching master competition. Based on teachers' voices identified in this study, the following section discusses implications for practice, policy-making, and future research directions.

## Conclusion

This qualitative study investigated the experiences of a group of teachers' professional learning that focuses on the ICT-related curriculum in China. It was found that participants had received various professional learning opportunities related to ICT implementation and relevant curriculum. The analysis shows that although these opportunities were offered by different organizations, they all paid much attention to the technical level of ICT use. Following previous research (Dong, 2014; Blackwell et al., 2016), this study argues that the narrow focus on professional development would not guarantee better ICT implementation. The findings also show that some professional learning opportunities were for the teachers' sake rather than the children's sake, as organizers prioritized professional learning and practice while paying less attention to the influences on children's learning and development. In line with some previous studies in China (Song et al., 2014; Huang et al., 2019), this study found that some professional learning opportunities did not occur in the classroom-based format, which would cause a gap between professional learning and teaching practice and even consume teachers' time and energy.

This study has strengths in developing an in-depth understanding of how a small group of kindergarten teachers have experienced ICT-related professional learning opportunities and providing rich descriptions of the contexts. Although this study was conducted in China and the findings should be understood with caution in relation to other contexts, it still makes significant contributions. First, considering the gap in this research topic, this study contributes to the current understanding of ICT-related professional development by discussing the complexities of different professional development activities. Second, the culture underpinning professional development (teacher competition in particular) in ECE in China, which seems viewing-oriented, has not been explicitly discussed in the literature. Therefore, this study provides empirical evidence for the current situation of professional development in China and an in-depth discussion about the influence of the social and cultural traditions on teachers' professional learning. Third, this study shed light on theories concerning teacher knowledge components around the use of ICT, as the findings demonstrate that the development of a single knowledge base (for example, technological knowledge) would not result in the development of the entire body of TPACK. Thus, this finding adds more evidence about the complex interrelations between TPACK components. Researchers have suggested that teachers need to transform their PK to TPK for ICT implementation (Nikolopoulou and Gialamas, 2015; Angeli et al., 2016; Blackwell et al., 2016) while this study argues that teachers may struggle with the transformation without appropriate professional learning opportunities.

The findings of the study make some implications for teachers, principals, policy-makers and researchers in terms of practices, professional development programs, and future research directions. First, this study follows previous researchers' recommendations (Gibbons, 2010; Vidal-Hall et al., 2020), arguing that more practice-oriented professional learning is needed for supporting teachers' ICT implementation in the kindergarten curriculum. A learning community that involves curriculum-based and classroom-based learning opportunities, teachers' active participation, peer discussion, and critical reflection could be an approach to ICT-related professional development (Johnston et al., 2020). These professional learning opportunities can help teachers engage in observation and critical reflections on current ICT implementation to bring about change in practice (Vidal-Hall et al., 2020). Considering the narrow focus of professional learning identified in the study as well as the child-centric pedagogies advocated in recent education reform in China, it is also important to ensure early childhood teacher education and professional development program to provide ongoing support for teachers to go beyond the "operating" aspect of ICT implementation, and to develop knowledge about ICT use for supporting children's free play and self-initiated activities (i.e., technological pedagogical knowledge). This would guarantee teachers implement ICT based on curriculum content, pedagogical purposes, and children's actual needs and interests (Yang, 2022).

Second, the findings imply that principals and policy-makers need to evaluate the benefits of teaching-research activity and its influence on teachers' practice as well as children's learning. As researchers have argued that the environment (school culture, in particular, see Zhang and Ng, 2011) profoundly shapes teacher development, this study calls for changes in the top-down decision-making process about teachers' participation in professional development. It is necessary for principals to empower teachers to make their own decisions about whether and in what ways to participate in professional development (such as teacher competitions). Dialogues between teachers and principals to create a shared understanding in relation to ICT implementation (Johnston et al., 2020) and professional learning (Song et al., 2014) are also needed. More importantly, principals should re-think the potentially negative influences of professional development (such as lesson-polishing) on children's development and policy-makers should prioritize this aspect when designing professional development programs.

Some issues about teachers' ICT-related professional learning have been found in the three kindergartens under the study, but

have not been addressed in this article. Therefore, there is a need to conduct further investigation into research questions such as what types of professional development can support teachers to implement ICT appropriately. Based on the issues about teacher competitions found in the study, future researchers can also examine in what ways this professional development approach facilitates teachers' teaching skills and ICT competencies. Investigation into these aspects will then provide more empirical evidence for stakeholders and assist them to modify professional development approaches to facilitate teachers' practice.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by University of Auckland Human Participants Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

TY is mainly in charge of the research design, data collection, data analysis, and drafting the manuscript. XH is responsible for conception of the work and the revision of the manuscript. All authors contributed to the article and approved the submitted version.

## Funding

This work was funded by the International Joint Research Project of Faculty of Education, Beijing Normal University (Approval No. ICER202202) and Guangdong Provincial Education Science Program (grant number 2022GXJK421).

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer XL declared a shared affiliation with the authors TY and XH to the handling editor at the time of review.

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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 02 June 2023
DOI 10.3389/fpsyg.2023.1154864



OPEN ACCESS

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RECEIVED 31 January 2023
ACCEPTED 18 May 2023
PUBLISHED 02 June 2023

CITATION
Xie S, Yin H, He M and Li H (2023) Classroom walkthroughs as an effective strategy for preschool improvement during the COVID-19 lockdowns: a Chinese model.
*Front. Psychol.* 14:1154864.
doi: 10.3389/fpsyg.2023.1154864



# Classroom walkthroughs as an effective strategy for preschool improvement during the COVID-19 lockdowns: a Chinese model

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Classroom walkthroughs are a widely used strategy for school improvement, varying over contexts and times. This study aims to explore the Chinese model of classroom walkthroughs in early childhood settings (ECS) during the COVID-19 lockdowns through a triangulated qualitative study. First, a group of ECS leaders ($N$=15; $M_{\text{year of teaching experience}}$=18.87, $SD$=7.74, range=6–33 years) and a group of teachers ($N$=15; $M_{\text{year of teaching experience}}$=8.40, $SD$=3.96, range=3–19 years) were interviewed in early 2022, and leaders' observations notes were reviewed. The interview data were transcribed, recoded, and analyzed using an inductive approach, and the walkthrough documents were examined as a triangulation. Four themes and 13 subthemes emerged from the interview data: content, pedagogical skills, tasks, and challenges pertaining to classroom walk-throughs. Two major challenges against efficient classroom walkthroughs during the COVID-19 lockdowns were found: building community and feeding forward. Based on the results, a Chinese model of classroom walkthrough was proposed. Implications for quality improvement were also addressed.

KEYWORDS

**classroom walkthroughs, quality improvement, early childhood education, qualitative study, interview**

## 1. Introduction

Classroom walkthroughs are a widely used strategy for quality improvement that requires both data-gathering and relationship-building continuously (Rouleau and Corner, 2020). This is because, as a school-changing supervisory practice, walkthroughs could facilitate teachers' professional growth and, ultimately, (pre-)school improvement (Downey et al., 2004, 2009). There are varieties of classroom walkthroughs suited for different purposes and contexts, as local cultures and school systems have profoundly shaped them. Therefore, good walkthrough practices should be culturally and contextually appropriate to empower data collecting and relationship-building for school improvement. However, the existing studies have primarily focused on the walkthroughs in primary and secondary schools, leaving those in early childhood settings (ECS) underexplored (Muijs et al., 2004; Ressler et al., 2016; Perlman et al., 2020). Furthermore, the limited studies on ECS walkthroughs have focused on the American context (Perlman et al., 2020), neglecting the

practices in other contexts, such as China, which has encountered the first outbreak of COVID-19 in the world. Since January 2020, Chinese schools and preschools have gone through repeated lockdowns, and the quality of teaching and learning has been deterred. Therefore, it is meaningful and timely to understand how Chinese preschools have practiced classroom walk-throughs during the lockdowns and thus to reflect on the lessons and experiences. To fill this research gap, the present study explored classroom walkthroughs through a triangulated qualitative study in southern China, aiming to provide a Chinese model of classroom walkthroughs.

## 1.1. Classroom walkthroughs as an effective approach for school improvement

Classroom walkthroughs are defined as "short, informal observations of classroom teachers and students by school administrators, coaches, mentors, peers, and others, followed by feedback, conversation, and/or action" (Stout et al., 2013, p. 1). Over the past years, it has been labeled with multiple names, such as "learning walks, instructional walks, walk-abouts, data walks, administrative walkthroughs, supervisory walkthroughs, reflective walkthroughs, and just walkthroughs" (Stout et al., 2013, p. 1); or "informal observations, pop-ins, walk-ins, or drop-ins" (Zepeda, 2013, p.18), with varied forms and processes. For example, Downey et al. (2004, 2009) developed a 3-min observation protocol to foster professional growth through reflective dialogue, while Colvin et al. (2009) conducted 10-min observations, provided feedback to teachers, and collaboratively developed action plans with teachers to improve instructional approaches in a high school. It is one form of instructional supervision and serves as a transformative tool to gather information to holistically support leaders, teachers, and student achievement and eventually guide improvement (Garza et al., 2016; Glickman et al., 2017).

Existing studies have preliminarily explored the factors related to classroom walkthroughs, such as directors' characteristics and approaches that facilitated effective classroom walkthroughs and, eventually, quality improvement in early childhood settings (Rous, 2004; Liu et al., 2020; Perlman et al., 2020). Interestingly, directors' characteristics showed no or even negative associations with supervision practices, and their working experiences were negatively related to quality scores using the Early Childhood Environment Rating Scale (Perlman et al., 2020). Participating in the walkthrough builds a sense of investment in the leaders (or supervisors) and grows into an effort to tailor teaching instruction and practice to help school improvement (Bole and Farizo, 2013; Moss and Brookhart, 2015, 2019). Therefore, supervisory approaches or pedagogical skills during classroom walkthroughs, instead of demographic characteristics, might lead to differences in quality improvement (Rous, 2004; Burns and Badiali, 2016, 2018; Glickman et al., 2017). Teacher mistrust, in contrast, can undermine walkthroughs (Romano, 2014; Khun-Inkeeree et al., 2019); thus, community and trust building are essential for the walkthrough to have an impact (Caruso and Fawcett, 2006; Glickman et al., 2017). However, most existing studies have focused on American contexts, leaving the classroom walkthroughs in other contexts underexplored (Rous, 2004; Garza et al., 2016; Khun-Inkeeree et al., 2019).

## 1.2. Classroom walkthroughs in Chinese early childhood settings

China's early childhood education system consists of two levels: nurseries that provide childcare services to children aged 0–3 and kindergartens (preschools) that provide education and care services to children aged 3–6. This paper focuses on early childhood education for 3- to 6-year-olds, given its rapid development in the past decade. Early childhood education in China has gone through rapid change since the promulgation of the *Outline of National Plan for Medium- and Long-term Education Reform and Development* (2010–2020) ('the Plan') and the *State Council's Several Opinions on the Current Development of Early Childhood Education* ('the Opinions') in 2010. The "3A" problem (accessibility, affordability, and accountability) since the 1990s was tackled by the Plan and the Opinions and ensuing national documents (Li et al., 2016; Xie and Li, 2020). Currently, the accessibility and affordability problems have been largely relieved by the establishment of Puhui (inclusive and inexpensive; 普惠) preschools, reflected by the gross enrollment rate rising from 50.9% in 2009 to 88.1% in 2021 (Ministry of Education, 2010, 2022a) and the restricted fees of the Puhui preschools (Xie and Li, 2020; Zhou et al., 2022). The problem of accountability, on the other hand, is an ongoing and continuous effort, as the Ministry of Education issued the *Guidelines on the Assessment of Preschool Care and Education Quality* in 2022 ('the Guidelines'; Ministry of Education, 2022b), which marks the nation's attention to improving quality in early childhood education.

Classroom walkthrough is an indispensable part of China's teaching research system in early childhood education. It is also an essential work of preschool leadership in early childhood settings in China. First, there exists a well-established, multi-layered teaching research system through which the principal (director), deputy principal (director) of academic affairs, the teaching and research staff, and teachers work together to design, deliver, and revise their instructional practices to promote quality (Huang et al., 2010, 2014). Second, preschool principals are required by the *Professional Standard for Preschool Principals* to "establish a system of going into the classroom to guide care and education activities, using daily observations and planned to observe activities to understand and evaluate the care and education situation in a timely manner and give constructive feedback" (Ministry of Education, 2015). The principal (director), the deputy principal (director) of academic affairs, and the teaching and research staff, who constitute the management team or "leading team" of academic affairs, usually conduct classroom walkthroughs. However, with the rapid expansion of new preschools, many young directors are starting to lead the preschools without experience and training in effective classroom walkthroughs (Liu et al., 2020). Despite its prevalence in daily practice, classroom walkthrough is underexplored in the Chinese context, especially in early childhood education. Some Chinese studies have proposed different types of classroom walkthroughs for deputy directors of academic affairs (Ma and Li, 2014) and examined educators' sense of the value of deputy directors' practice of classroom practice (Liu et al., 2020). However, there lacks a comprehensive understanding of both the supervisors' and supervisees' views of classroom walkthrough and how it relates to quality improvement in Chinese early childhood settings, which is a remarkable research gap the current study intends to fill.

### 1.3. The current study

The COVID-19 pandemic has caused repeated lockdowns in China since 2020, Chinese preschools thus have to make more efforts to keep the quality of teaching and to learn under this difficult circumstance. Accordingly, Chinese principals and teachers must overcome all the challenges caused by the lockdowns to conduct classroom walk-throughs. This study aims to examine whether classroom walkthroughs serve the goal of quality improvement in early childhood education in China. The exploratory nature of this study allows illumination of the perceptions of preschool leaders and educators regarding the classroom walkthrough and its potential. In particular, the following research questions guided the current study:

1. What is the model of classroom walkthroughs commonly shared by Chinese early childhood leaders and educators?
2. What are the challenges to the classroom walkthroughs during the lockdowns?
3. Overall, does classroom walkthrough practice serve the goal of quality improvement in early childhood education in China?

## 2. Methods

### 2.1. Participants

The study took place in 2022 in the Shenzhen Special Economic Zone, one of China's fastest-growing cities and the third-largest city in terms of GDP (Xie and Li, 2020). The only super-mega city neighboring Hong Kong, Shenzhen is the main entrance to Mainland China for those visitors from Hong Kong and overseas. However, since January 2020, Shenzhen has undergone three waves of city-wide lockdowns and multiple sub-district-wide quarantines to thoroughly implement the nationwide 'Zero Case' policy while receiving visitors from Hong Kong every day. Thus, Shenzhen has served as the frontline of the nation's war against the COVID-19 pandemic. Accordingly, Shenzhen preschools and schools had to suspend or lock down repeatedly. Inevitably, this problematic situation has negatively affected the quality of teaching and learning in Shenzhen preschools, making it more challenging to conduct classroom walk-throughs as usual.

The research project was reviewed and approved by the first author's University Human Research Ethics Committee, and the project was conducted in accordance with human subject guidelines. Eight public preschools were purposefully selected from Shenzhen to represent preschools of varied quality grading and in different developmental stages: some were public preschools from the start with varying years of establishment, and others were initially privately run but were transformed into publicly run. Preschool principals were first contacted and explained the purpose of the study. After their consent to participate in the study was given, we contacted and arranged one-on-one interviews with the supervisors (including principal/director, deputy principal/director of academic affairs, and the teaching and research staff; $N = 15$) and supervisees (teachers; $N = 15$). Fourteen of the 15 supervisors had bachelor's degrees, and one had a master's degree. Similarly, 14 out of the 15 supervisees had bachelor's degrees, and one had an associate degree, showing no significant differences in their educational attainment. However, the supervisors had significantly more years of teaching experience than the supervisees ($M_{supervisor} = 18.87$, $SD = 7.74$, range = 6–33 years; $M_{supervisee} = 8.40$, $SD = 3.96$, range = 3–19 years; $t = 4.67$, $p < 0.001$).

### 2.2. Procedure

Each participant was contacted and scheduled for a semi-structured interview in a quiet room of the preschool they worked. Their consent to participate was obtained before the interview started and was recorded. The interview protocol was written in Mandarin Chinese, and all the interviews were conducted in Mandarin Chinese. During the interview, open-ended questions were asked with prompts to clarify participants' responses or to elicit further discussion. Closing remark in which participants were given opportunities to ask questions and were thanked for their participation.

### 2.3. Measure

The semi-structured interview protocol was used. The following open-ended questions were relevant to the practices and perceptions of classroom walkthroughs in their preschool. Questions for the supervisors and supervisees were slightly different according to their roles (see Supplementary Appendix).

The interviews were audio-taped and transcribed, resulting in approximately 98 pages of single-spaced transcription for analyses.

### 2.4. Data analysis

The transcriptions were sent to the participants to verify that the transcriptions accurately represented their perceptions. The participants were encouraged to amend the transcripts when they felt that the transcripts did not communicate what they had intended to say or when they wanted to add additional information. Three participants returned transcripts with minor corrections on inaccurate transcription of individual words. After that, information identifying the participants was removed, and each transcript was assigned a code for further analysis.

The researchers were outsiders of the preschools in the current study and therefore an inductive approach was used to analyze the data and identify themes stemming from the data (Miles et al., 2019). Three coders coded the data. One coder held a Ph.D. in early childhood education, and two coders were master students in early childhood education and were trained to code classroom walkthroughs reliably. The first two coders examined the data line by line and independently coded the transcripts using NVivo version 11 (QSR International, Melbourne, Australia). Initial descriptive and process codes were identified in this first round of the coding phase (Miles et al., 2019). In the second round, connections and comparisons among the codes were examined to develop themes and subthemes (pattern coding; Miles et al., 2019, p. 86). The third coder read the transcript and identified the themes which were later discussed among all three coders. They discussed developing complete definitions and identifying areas of agreement and disagreement. During such a process, codes were revised or reduced, resulting in refined codes

(Miles et al., 2019). In the third and final round, the two coders then re-read the transcripts to confirm the set of codes and themes; any coding differences were discussed until a complete agreement was reached. No new themes emerged, suggesting data saturation was achieved (Saunders et al., 2018). Links and relationships among the confirmed themes and subthemes were established. Additional coding was conducted to understand if the roles of the participants (i.e., supervisor or supervisee) offered unique insights.

To establish methodological triangulation and trustworthiness (Corbin and Strauss, 2014; Creswell, 2014), observation notes were also used to cross-check the interview analyses. The researcher collected all available observation notes with the leaders' informed consent. Because supervisees (teachers) were usually observed and given written or oral suggestions by the supervisors, only observation notes by the supervisors were collected and analyzed in NVivo using the codes from the interview study to see if the findings were supported.

# 3. Results

## 3.1. Themes

Figure 1 shows the four main themes and 12 subthemes that have emerged from the data analysis: content, pedagogical skill, outcome, and challenges pertaining to classroom walkthroughs. The participants described the content supervisors focused on, the interpersonal behaviors or strategies adopted during classroom walkthroughs, and the outcomes and challenges of classroom walkthroughs. Below we elaborate on these themes and ensuing subthemes and provide illustrative quotes as appropriate.

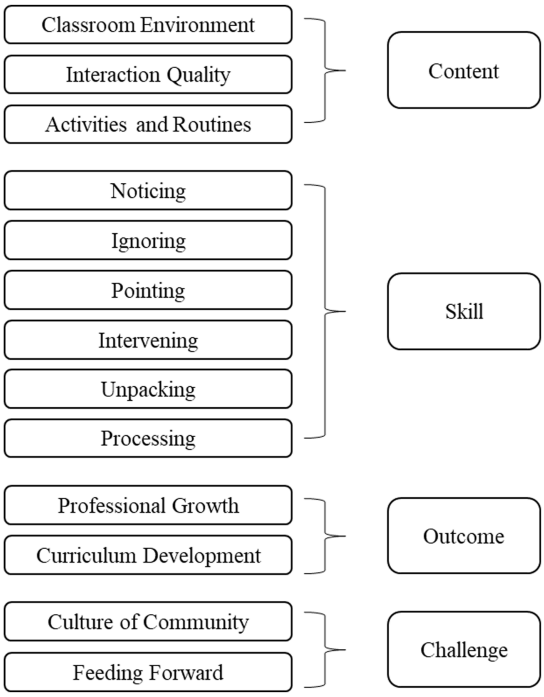


FIGURE 1
Themes and subthemes.

### 3.1.1. Content of classroom walkthroughs

Three main contents were focused on during classroom walkthroughs: classroom environment, interactional quality, and activities and routines (Table 1). These three contents were considered crucial aspects of enhancing quality in preschool. During the brief walkthroughs, the supervisors would attend to these critical issues as indicators for supervision. It was interesting to find that the supervisors and supervisees expressed evenly of the contents, except for interaction quality, with twice as many supervisors mentioning interaction quality as the supervisees (46.67 and 20.00%, respectively). The observation notes supported that the supervisors generally focused on classroom environment, interaction quality, and activities and routines, with varied foci of attention during each walkthrough.

#### 3.1.1.1. Classroom environment

The participants described various issues in the environment that would be attended to during walkthroughs, with safety practices as "foremost important," such as safety hazards that could result in severe injury or adequate supervision to protect children's safety (e.g., supervision near areas of potential danger). When safety practices were ensured, materials provided in different learning corners were the following concern: noticing if the materials were appropriate and engaging. Finally, print and artwork displayed in the classroom were checked if they were related to the undergoing project or other classroom experiences (e.g., paints in spring colors when learning about seasons).

#### 3.1.1.2. Interaction quality

Two kinds of interaction quality were frequently mentioned as essential during classroom walkthroughs. The first was teacher-child interaction, which included whether the teacher supported children's learning and critical thinking, whether a balance was maintained between the child's need to explore independently and the teacher's input into learning, and whether the teacher encouraged the development of mutual respect between children and adults.

The second was teacher–teacher interaction, where positive, warm, and supportive interaction models mutual respect for children. Furthermore, whether the responsibilities of each teacher in the room were clearly defined to ensure all children were supervised was also an important aspect during walkthroughs.

#### 3.1.1.3. Activities and routines

Participants mentioned that activities, routines, and transitions between activities were attended to during classroom walkthroughs, including the arrangement of the daily schedule, teacher's talk during circle time, teachers' instructions during group learning activities (projects), small-group learning activities and outdoor activities, personal care routines, as well as the transition between activities. It was worth noting that preschools might feature different focuses during classroom walkthroughs regarding the activities and routines. For example, participants from one preschool have highlighted areas featuring science learning as their focus, which was set as the target area of improvement for that term.

### 3.1.2. Pedagogical skills of classroom walkthroughs

The conceptual framework for clinical pedagogy by Burns and Badiali (2018) was used, and the participants identified six pedagogical skills: noticing, pointing, ignoring, intervening, unpacking, and

TABLE 1 Unique respondents who reported on the content of classroom walk-throughs.

| Content of classroom walk-throughs | Supervisor *N* (%) | Supervisee *N* (%) | Quotations |
|---|---|---|---|
| Classroom environment | 36.67% | 30.00% | "Next, I will go to the learning corners to see whether children are interested and curious in exploring the materials, whether there is a wide range of provisions available, and whether the materials are age-appropriate." (R6) |
| Interaction quality | 46.67% | 20.00% | "One more issue is teacher-child interaction. Are there too much or too few interactions? When a child encounters a challenge, does the teacher intervene at once, or does the teacher allow opportunities for exploration? I also check if the teachers are paying attention to details during children's learning." (R13) |
| | | | "I put a lot of attention in the details during teacher-teacher interactions, such as the communication between the teachers, including the tone of speech and attitude, as well as their body language." (R11) |
| Activities and routines | 46.67% | 43.33% | "I would intentionally check on the progress of undergoing projects in each class. I will first look at the materials posted on the "project wall" and then ask the teachers to briefly walk me through the project." (R5) |

TABLE 2 Unique respondents who reported on the pedagogical skills of classroom walk-throughs.

| Pedagogical skills of classroom walk-throughs | Supervisor *N* (%) | Supervisee *N* (%) | Quotations |
|---|---|---|---|
| Noticing | 50.00% | 33.33% | "During classroom walk-throughs, I would notice teachers or children have some issues that raised my attention. Usually, when I notice such an incident, I would first look around other classrooms to decide if it is a common or individual issue. If I find it a common issue, I will write it down and arrange a research seminar to discuss it." (R7) |
| Ignoring | 46.67% | 23.33% | "But some teachers might be more sensitive, so that I would leave the classroom first. Because sometimes if I intervene immediately, the teacher might feel embarrassed and not lead to positive outcomes." (R11) |
| Pointing | 33.33% | 43.33% | "Sometimes, when the supervisor noticed some minor or adjustable issues, she would talk to us face-to-face and give us some feedback on some rules of organizing activities or things to pay attention to." (E3) |
| | | | "For some issues, I would send photos with some text descriptions to the teachers (supervisees). For example, I would describe what kind of incident was shown in the photo. I would try to use the simple description to point out the issue to the teacher." (R6) |
| Intervening | 33.33% | 44.44% | "If it is a safety issue, I will immediately point it out or make a rapid adjustment." (R6) |
| | | | "The supervisor will tell us on the spot how to use the materials to make it more fun. She will directly give us suggestions and also encourage us to make DIY learning materials and do more research." (E11) |
| Unpacking | 46.67% | 20.00% | "For example, I will ask the teacher to share her feeling about the day or any reflections, and then I will pick up what the teacher said and provide my feedback. Or, I will directly describe the issue I noticed and ask the teacher what she was thinking at that moment. Based on the teacher's response, I will share my thoughts." (R4) |
| Processing | 50.00% | 36.67% | "If it is a common issue, I will mention it at the staff meeting and do some research with my teaching and research staff. For example, not long ago, I noticed during a classroom walk-through that the materials in the block areas were minimal in more than half of the classrooms. So I discussed with the teaching and research staff how to solve this problem." (R10) |

processing (Table 2). Because the skills focused on the supervisors, not the supervisees, there were more respondents from the supervisors than the supervisees who mentioned these six subthemes. The observation notes included descriptions of the content they observed and generally attached supervisors' evaluations and suggestions on this content.

#### 3.1.2.1. Noticing

It was generally considered the first step during the walkthrough, as mentioned by participants of the regular or irregular behaviors noticed by the supervisors. Regular behaviors referred to whether teachers follow the expected schedule or protocol of teaching, and irregular behaviors referred to incidents that were distinguishable and marked for later discussion. Supervisors generally observed and identified these "critical issues," and documented these incidents through physical markings, such as writing observation, taking pictures or videos or audio-recording, and mental marking, such as cognitive awareness of the incident. The supervisor then decided the next action step based on the incident's nature, which led to other pedagogical skills discussed below.

TABLE 3 Unique respondents who reported on the tasks of classroom walk-throughs.

| Tasks of classroom walk-throughs | Supervisor *N* (%) | Supervisee *N* (%) | Quotations |
|---|---|---|---|
| Professional growth | 73.33% | 93.33% | "Because during each classroom walk-through, the supervisors would provide some professional suggestions. For example, the supervisors provided advice on how to design diversified worksheets, scaffold children's exploration, and diversify the materials in the learning corners. I would reflect on my practices and adjust my strategies each time after their feedback. This is very helpful to my professional growth." (E4) |
| | | | "Sometimes, during classroom walk-throughs, I will stay in one classroom to observe and document. These are what we (as supervisors) need to do to understand teachers' needs and support teachers' professional growth, which is also a path for our own professional growth." (R3) |
| Curriculum development | 26.67% | 93.33% | "For example, we were doing a project on tree house. Children were supposed to build a model, and they were very excited. When the supervisor came to our class, she gave me a very good idea. She said an excellent facility is near our preschool; we should share this resource with the children. She also advised me to buy certain things, to support children's exploration using these materials in the classroom." (E9) |

#### 3.1.2.2. Ignoring

After noticing, supervisors may intend to ignore, with deliberate knowledge of something happening and deliberate choice of inaction. It was an elusive skill unless the supervisor disclosed that she noticed the incident and chose to ignore it. The reason for ignoring might be avoidance of interruption to the class or embarrassment to the supervisee. Thus, actions might be taken at late times.

#### 3.1.2.3. Pointing

It was an action after noticing, which drew another's attention to a specific incident. Pointing included disclosure by sharing videos or pictures with others as a model of good practice and providing written or oral feedback to the supervisee. Both ways showed elements of directed attention by making the incident and the supervisors' perspective visible.

#### 3.1.2.4. Intervening

It was an immediate action due to the incident noticed by the supervisor. Intervening was frequently used when supervisors noticed safety hazards to reduce the possibility of child injury. It was less frequently used to support the teacher's instruction so that teachers may directly learn more about effective practice.

#### 3.1.2.5. Unpacking

It was a higher level of pointing by breaking down a complex critical incident into simpler components, with the intention of inducing reflective thinking in the supervisees. Unpacking may come in the form of telling, by describing the incident and extrapolating meaning out of the incident, or the form of questioning, by helping the supervisee to think and extrapolate.

#### 3.1.2.6. Processing

It was a reflection process that the supervisors and supervises understood the incident and decided upon the next step of action, usually in the form of preschool-wide professional learning activities or staff meetings. Incidents that were frequently noticed would be the target of discussion for professional learning activities, and both parties would derive potential actions together. Most importantly, these actions would be noticed by the supervisors in the next round to see if the issues were solved.

### 3.1.3. Outcomes of classroom walkthroughs

There were two major outcomes of classroom walkthroughs identified by the participants, with teacher professional development frequently mentioned as one of the important functions of classroom walkthroughs and curriculum development as another function (Table 3).

#### 3.1.3.1. Professional growth

Participants, especially supervisees, frequently described that classroom walkthroughs constantly reminded teachers to do their best and sometimes noticed some inappropriate practices that teachers themselves did not realize, indicating the "normative" function of supervision that intended to ensure quality. Seven participants also described that the objective feedback, as well as timely assistance, supported teachers' practices, indicating the "restorative" function of supervision. Finally, 21 participants responded that classroom walkthroughs provided opportunities for self-reflection on their actions which helped develop their strategies and skills, indicating the "formative" function of supervision.

Apart from teachers' professional development, participants, especially supervisors, mentioned their professional development of themselves. The supervisors described the reflections on their own behaviors during classroom walkthroughs and how they adjusted their supervision skills to help teachers grow. Two of them have also expressed the concern of lack of experience in conducting classroom walkthroughs and instructional supervision, which echoed one supervisee who expressed her expectation upon the supervisors to hold certain competencies before conducting supervision. Four of the observation notes included supervisors' own reflections on the content, such as question marks on the comment, indicating that the supervisors themselves were going through reflection toward professional development.

#### 3.1.3.2. Curriculum development

Another task of classroom walkthroughs is to support curriculum development. Supervisors would provide ideas to help supervisees design materials and deliver learning activities that can better support children's learning.

TABLE 4 Unique respondents who reported on the challenges of classroom walk-throughs.

| Challenges of classroom walk-throughs | Supervisor *N* (%) | Supervisee *N* (%) | Quotations |
|---|---|---|---|
| Building culture of community | 66.67% | 73.33% | "Honestly speaking, I do not want to be observed. If there is no classroom walk-through, I will not feel the pressure from outside, so that I could be myself and flexibly arrange the learning activities." (E8)<br>"The supervisors do not come to nitpick; they come to provide professional suggestions. When I realize that, I become less nervous and want to receive suggestions on professional growth during classroom walk-throughs. Furthermore, I want tailor-made walk-throughs. For example, when I think there are some problems in the transition, I can invite the supervisors to come and give us some suggestions. Though this is a very romantic way, I still think this can build teacher agency." (E14) |
| Feeding forward | 26.67% | 0% | "As deputy principal of academic affairs, I have to supervise 12 classrooms, which adds up to more than 30 teachers. Therefore, after providing feedback during the walk-through, I have no idea if the teacher solved the problem. It is a big challenge for me to follow up with each of them." (R6) |

#### 3.1.4. Lockdown-associated challenges to classroom walkthroughs

Aside from the contents, behaviors, and tasks of classroom walkthroughs, the participants also expressed the challenges of conducting efficient and productive classroom walkthroughs during the COVID-19 lockdowns (Table 4).

##### 3.1.4.1. Building culture of community

More than half of the participants expressed that supervisees were usually nervous and even overwhelmed when supervisors walked through the classroom, with very few describing themselves as being "business as usual." Stemming from this nerve caused by the COVID-19 lockdowns, there was a split between whether the supervisees expected to be observed or not, with five of supervisees expressed their expectations that the supervisors could provide new insights during classroom walkthroughs while others did not wish to be observed unnoticed but welcomed planned or invited observations. Finally, it was highlighted that authentic and collegial relationship with supervisees based on respect, compassion, and the common goal of improving children learning was crucial to maximizing the benefit of classroom walkthroughs. Thus, supervisors should strive to build a culture of community in achieving that goal, especially during difficult times.

##### 3.1.4.2. Feeding forward

During the classroom walkthrough, feedback was usually provided on the spot. However, three supervisors expressed the difficulty in following up with the issues noticed during the walkthrough, thus limiting the potential of classroom walkthroughs to "feed forward" the teaching and learning activities. It was interesting to find that none of the supervisees mentioned the problem of feeding forward, highlighting that the supervisees might not be aware of such a problem.

### 3.2. Model of classroom walkthrough in early childhood education

After a review of the themes and codes, a model of classroom walkthrough in early childhood education is proposed (see Figure 2). In this model, the *content* serves as the "focus" or the "tangibles" during classroom walkthroughs, through which supervisors become familiar with the teaching patterns and decisions that teachers make on a daily basis. The *outcome* serves as the "purpose" of classroom walkthroughs, which is also the purpose of instructional supervision: to promote both the supervisors' and supervisees' professional development and curriculum development. Down in the figure, there were two forces that were driving the classroom walkthroughs: a push force defined as pedagogical skills for classroom walk-throughs and a pull force defined as challenges confronting classroom walk-throughs. A better set of skills displayed by the supervisors would drive toward better outcomes, such as building reflective thinking in both supervisors and supervisees, an indicator of professional growth. On the contrary, the challenges associated with lockdowns hindered the endeavor toward better outcomes. Finally, a developmental perspective was adopted in this model in which the spiral course indicated that classroom walk-throughs were not a one-time effort. Instead, they should be brief, regular, and sustained over a long time, struggling between the push and pull forces in order to obtain quality improvement over time.

## 4. Discussion

Classroom walkthrough has become a prominent tool for instructional leadership practice that may involve leaders and educators in a collaborative process to observe, analyze, and evaluate the appropriateness of instructional practice (Caruso and Fawcett, 2006; Glickman et al., 2017) and eventually promote effective practice and achieve quality improvement (Ovando and Ramirez, 2007; Garza et al., 2016). This exploratory study revealed the content, outcome, skills, and challenges pertaining to classroom walkthroughs in China during the COVID-19 lockdowns and proposed a model of classroom walkthrough to depict how classroom walkthrough serves as an effective approach toward quality improvement in preschools.

### 4.1. Chinese model of classroom walkthroughs

First, this study found that the content of the classroom walkthroughs included classroom environment, interaction quality, as well as activities and routines in the classroom. Comparing them with the standardized quality assessment tools such as ECERS, Classroom Assessment Scoring System (CLASS), and Individualized Classroom Assessment Scoring System (inCLASS) and the national quality assessment guidelines revealed that the commonly used indicators in the assessment tools can be observed during classroom walkthroughs, providing evidence that walkthrough can be a competent observational

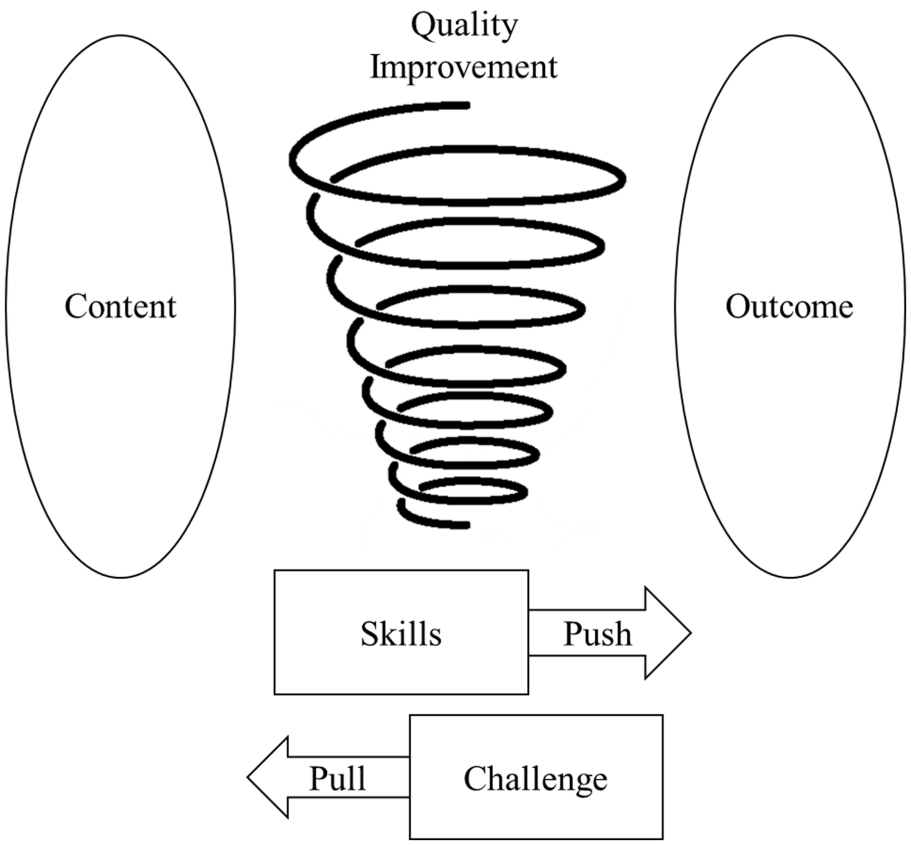


FIGURE 2
Model of classroom walk-through in early childhood education.

tool for improving instructional practice (Zepeda, 2014). However, there are scant studies that examined the quality improvement of early childhood education programs over time (Kuger et al., 2016), and among the limited evidence, one study found that there was a substantial quality improvement in CLASS across the state of Louisiana, U.S.A. and that this improvement was driven by within-program changes (Bassok et al., 2021). The driving force of such improvement was substantial federal, state, and local investments, which are external efforts. On the contrary, supervision leadership, including classroom walkthroughs, are internal efforts toward quality improvement, which are more sustainable and pervasive (Downey et al., 2004, 2009; Glickman et al., 2017).

Second, this study found the outcome of classroom walkthroughs, including professional growth and curriculum development. In particular, the impact of classroom walkthroughs on the professional growth of educators corroborated with existing evidence that found leaders' supervisory practices were related differently to educators' performance, competency of teaching, and teaching efficacy (Darishah et al., 2017; Khun-Inkeeree et al., 2019, 2020; Hoque et al., 2020). However, the relationship between classroom walkthroughs and the professional growth of the center leaders was less explored in the literature, calling for more support to center leaders, such as observational tools, in their efforts to improve ECEC quality. The findings also revealed the role of classroom walkthroughs in curriculum development, with educators expressing their need for sustained support from the leaders in developing the curriculum, highlighting how ECE leaders provide appropriate and sustainable curriculum practices (Yang, 2019). It is worth noting that too much top-down monitoring limits educators' autonomy in curriculum decision-making (Li and Chen, 2017; Yang, 2019), and therefore the findings also highlighted educators' preference for leaders to "answer" their specific needs rather than guidance in general.

Therefore, this study proposed a model of classroom walkthrough in Chinese preschools, putting important factors into a unified model. This model used a developmental perspective, recognizing the push (pedagogical skills) and pull (challenges) forces that drive quality improvement in the long term. The current findings suggested that classroom walkthrough can serve as an effective approach toward sustainable quality improvement in early childhood education (Caruso and Fawcett, 2006; Stout et al., 2013; Moss and Brookhart, 2019), though much effort and training is needed to reach the goal of quality education for our young children.

## 4.2. Challenges and pedagogical skills

First, this study revealed two major challenges against efficient classroom walkthroughs during the COVID-19 lockdowns. The first challenge, building community in the center, corroborates with educators' prevailing mixed attitudes toward such supervision practice in existing studies (Darishah et al., 2017; Khun-Inkeeree et al., 2019; Hoque et al., 2020). Teachers generally agree that classroom walkthroughs would benefit their professional development and curriculum development as a whole, but interpersonal skills were the barriers, as was found in a study in Malaysia (Khun-Inkeeree et al.,

2019). More studies are needed to explore the effective walkthrough process in promoting a collaborative learning culture (Moss and Brookhart, 2015, 2019; Glickman et al., 2017). The second challenge, feeding forward, though less explored in the existing literature, can be instrumental in helping both leaders and educators better understand the need for evidence-based change and improvement in instructional practices and deserve further research (Stout et al., 2013; Moss and Brookhart, 2019).

According, this study also explored the pedagogical skills pertaining to classroom walkthroughs, using the framework by Burns and Badiali (2016, 2018). The findings found that the six pedagogical skills were important for enhancing school effectiveness, which is consistent with the existing evidence that leaders' supervision practices contribute to the quality of ECE programs (Bloom and Sheerer, 1992; Vu et al., 2008; Bloom and Abel, 2015). A more recent study in Australia, however, found a lack of association between director's supervision practices and classroom quality indicated by ECERS-E and CLASS (Perlman et al., 2020), calling for more research to explore the impact of supervisory practice. Furthermore, the findings indicated that the process of learning how to supervise well could be challenging for the supervisors (leaders) since the lack of in-service training for supervisory skills, especially those pertaining to classroom walkthroughs (Burns and Badiali, 2016; Perlman et al., 2020).

## 5. Limitations and conclusion

The limitations of the current study are worth mentioning. First, the current study only utilized interview and document analysis to understand ECE leaders' and educators' perspectives on classroom walkthroughs. Future studies that include questionnaires and classroom observation would substantiate and triangulate the findings from interviews. Second, the current study was conducted in one city in China, with might not be representative of all the ECE settings, especially those in less developed parts of the country. The future study shall compare and investigate whether there were differences in the content, skills, outcome, and challenges of the classroom walkthrough in centers from different socioeconomic backgrounds. Last but not least, this study was conducted during the lockdowns; without the data collected before the outbreak of the COVID-19 pandemic, it is impossible to compare the differences in classroom walkthroughs between the lockdown and usual times.

Despite the limitations, the current study explored ECE leaders' and teachers' perspectives on classroom walkthroughs, investigated the content, skills, outcome, and challenges pertaining to classroom walkthroughs, and proposed a Chinese model of classroom walkthrough in early childhood education from a developmental perspective. The findings implied that a classroom walkthrough is an effective approach in improving quality even during the lockdowns, yet more in-service training for ECE leaders is needed to equip ECE leaders with appropriate pedagogical skills and to build a sense of community within the center to reach the goal of sustainable quality improvement. Furthermore, the findings of the current study provided implications for its use in other contexts, given the generally shared understanding in what is quality in early childhood education (Siraj-Blatchford and Wong, 1999) and how classroom walkthrough supports quality improvement in daily practices (Caruso and Fawcett, 2006).

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by Shenzhen University. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

SX and HL: conceptualization. SX: methodology, data curation, writing – original draft preparation, and supervision. HY and MH: formal analysis and project administration. HL: writing – review and editing. All authors have read and approved the final manuscript.

## Funding

This work was supported by the Guangdong Planning Office of Philosophy and Social Science, China (grant number GD21YJY09), Shenzhen Planning Office of Philosophy and Social Science (grant number SZ2022B031), and Shenzhen Education Science Planning Project, China (grant number zdzz21002).

## Acknowledgments

Thanks for the research assistants of the participating preschools to collect data for this study.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



## Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1154864/full#supplementary-material

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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 07 June 2023
DOI 10.3389/fpsyg.2023.1118787



OPEN ACCESS

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RECEIVED 08 December 2022
ACCEPTED 18 May 2023
PUBLISHED 07 June 2023

CITATION
Qian Y, Zhangchen S and Li H (2023) The 'Matthew effect' in Chinese kindergarten principals' professional development: a mixed-methods study.
*Front. Psychol.* 14:1118787.
doi: 10.3389/fpsyg.2023.1118787



# The 'Matthew effect' in Chinese kindergarten principals' professional development: a mixed-methods study

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Principals play a leading role in kindergarten quality improvement, and thus their needs for professional development (PD) should be understood and met. This national study adopted a mixed-methods approach to survey 3,065 kindergarten principals in China and interviewed 16 of them. First, the latent profile analysis of survey data yielded three profiles of PD needs: (1) low (7.5%), (2) medium (22.2%), and (3) high profiles (70.3%), indicating 70.3% of Chinese principals need PD badly. The high-profile group features 'inexperienced principals working at newly established private kindergartens', the most disadvantaged among the three groups. Second, ANOVA tests revealed significant rural–urban and public-private differences in Chinese principals' professional backgrounds and PD needs. In particular, significant public-private and rural–urban differences were observed in the principals' 'current degree' ($Fs>63$, $ps<0.001$) and 'desired degree' ($Fs>39$, $ps<0.001$). The rural principals aspired more than their urban counterparts to obtain 'a higher degree" or 'a certificate' ($ps<0.05$). Third, the follow-up interviews confirmed remarkable rural–urban and public-private gaps in PD needs, indicating a noticeable 'Matthew effect': the poor got less, whereas the rich got more. The implications for future PD policy and program development are discussed.

KEYWORDS

**kindergarten principals, professional development needs, early childhood education, Matthew effect, principal training**

## 1. Introduction

The 'Matthew effect' refers to a pattern in which those who begin with advantages accumulate more over time, while those who begin with disadvantages become more disadvantaged over time (Merton, 1968, 1973; Dannefer, 1987). This effect is extensively evident in Chinese early childhood education (ECE). For example, in China, public kindergartens (catering to young children ages 3–6) tend to have better educational quality and resources than private kindergartens. This is because the local governments only fund public kindergartens and leave those private ones fending for themselves, like 'Cinderella' crying in the kitchen. In addition, rural kindergartens often receive lower levels of funding than urban ones. These rural–urban and public-private gaps have further exacerbated the 'Matthew effect,' causing more significant educational inequalities and the associated '3A' problems (Li et al., 2017): 'accessibility' (more difficulty enrolling in public kindergartens in rural areas), 'affordability' (expensive tuition in private kindergartens), and 'accountability' (worse quality in rural and private kindergartens).

Since 2010, the Chinese government has drastically increased its input into teacher professional development (PD) to enhance the quality of teachers and principals. However, the financial input and professional resources went primarily to public kindergartens in urban areas, leaving those private rural ones unattended. The private-public dichotomy, urban–rural divide, and associated prejudices might have caused a 'Matthew effect' in early childhood teacher education. However, no empirical evidence has confirmed this phenomenon in the field of teacher PD, especially among kindergarten principals who play a leading role in kindergarten quality improvement (Rodd, 2001; Bloom, 2004; Bloom and Bella, 2005). To fill this gap, this study adopted a mixed-methods approach to explore the 'Matthew effect' in Chinese kindergarten principals' PD needs.

## 2. Literature review

### 2.1. The private-public and rural–urban gaps and Matthew effect in ECE

In 1903, the first Chinese public kindergarten was established in Wuhan. Since then, rural–urban and public-private ECE gaps have emerged and persisted. Existing studies have extensively reported these gaps in enrolment ratios, tuition fees, teacher-child ratios, and teachers' qualifications (Li et al., 2019; Qian, 2019; Qian et al., 2022). First, the enrolment rate in rural kindergartens was much lower than those in urban kindergartens. For example, in most metropolitan areas, enrolment in ECE was almost 100%, nearly 30% higher than that in some western rural regions (Qian, 2019). Second, private kindergartens' tuition fees are higher because they usually have fewer resources than public ones (Xie and Li, 2020). Third, the teacher-child ratio in rural areas was lower than in urban areas. For example, the teacher-child ratio was approximately 1:25 in Jiangsu, Chongqing, and Sichuan rural kindergartens, compared with 1:15 in most urban kindergartens (Gov. CHN-Department of Development and Planning of Chinese Ministry of Education, 2021). Fourth, the teachers' qualifications in rural or private kindergartens were lower than those in urban and public kindergartens (Luo, 2021; Yin, 2022).

As mentioned above, Li et al. (2017) described how rural–urban and public-private ECE gaps have caused the '3A' problems of accessibility, affordability, and accountability. These 3A problems in ECE will likely cause inequality in children's abilities, achievements, health, and professional success in adulthood. Moreover, as the Matthew Effect indicated, urban or public kindergartens that begin with advantages accumulate more over time, while those rural or private schools that start with disadvantages become more disadvantaged over time. To solve these problems, the central government released two critical documents, marking a new era for ECE services in China in 2010. The first was the *National Medium to Long Term Planning Outline for Educational Reform and Development* (the *Outline*), which stated three goals: (1) promoting the universal provision of ECE to provide fair opportunities; (2) increasing government responsibilities in developing public kindergartens and supporting private schools; and (3) facilitating rural kindergartens. The second document was the *State Council's Several Opinions on the Current Development of Early Childhood Education,* which prompted governments at all levels to strengthen PD for kindergarten teachers. Since then, ECE services in China have witnessed a 'Great Leap Forward' (Li et al., 2017).

According to the Chinese Ministry of Education's (MOE) *Statistical Bulletin 2021*, there are 48,182,600 children attending 291,700 kindergartens (123,700 of which are public and 168,000 are private). Approximately half of all children (50.63%) are enrolled in public kindergartens (49.37% are in private services). Furthermore, 128,650 (41.72%) are in urban kindergartens, and 179,370 (58.28%) are in rural areas. However, even though the enrolment rate has almost doubled over the past decade (by 2021, 88.1% of children nationwide were enrolled, compared with 50.9% in 2009), the rural–urban and private-public gaps remain an issue. Recent studies reported that the quality of rural and private kindergartens tends to lag behind that of urban and public schools (Zhang et al., 2020; Jiang and Liu, 2022). Furthermore, significant rural–urban and private-public gaps were identified in child outcomes regarding social skills, basic knowledge, language competence, and overall development (Zhang et al., 2020).

Therefore, as part of efforts to narrow the gaps between rural–urban and public-private kindergartens, the Chinese government has emphasized the importance of kindergarten principals' PD. In 2015, the educational authorities of China released the *Professional Standards for Kindergarten Principals* (the *"Principals' Standards"* hereafter) to promote kindergarten principals' PD. This document provides an 'important basis for formulating principals' qualification, PD program, and assessment standards'. Accordingly, many PD programs were sponsored and delivered by local and central governments, training institutes, and universities.

### 2.2. Professional development needs in Chinese kindergarten principals

Principals are responsible for a kindergarten's daily operations, supervising teaching staff, directing program planning, and administering overall performance (Rodd, 2001; Bloom, 2004; Bloom and Bella, 2005; Jiao and Liu, 2022). Currently, China has 308,380 kindergarten principals (some kindergartens have more than one principal); half are working in private kindergartens and half in rural areas. Their leadership is critical or decisive to school development and quality improvement (Sims et al., 2015). This is because they can create a climate that promotes children's optimal growth and development and implement effective educational systems (Kagan and Bowman, 1997; Bloom, 2004). In addition, several studies have indicated that effective leaders could improve service quality (Bloom and Sheerer, 1992; Rodd, 1997; Brownlee et al., 2009; Day and Sammons, 2016; Al-Hamad et al., 2020). As Grogin and Andrews (2002) claimed, 'the school principal is a key lynchpin between teacher development and school improvement' (p. 249).

However, most Chinese kindergarten principals are selected from the teacher team; thus, they often lack proper preparation and face a huge transition in their roles (Chen, 2022). As the national *Kindergarten Working Regulation (2016)* states, the kindergarten principal must have a teaching certificate, a college degree or above, more than three years of working experience in kindergarten, a certain amount of leadership, and a certificate for the principal's training. In previous studies, few principals stated they were well-prepared; most described the transition into their new administrative role as

overwhelming (Wu, 2021; Jiao and Liu, 2022). Therefore, they need specialized and continuous PD to develop their expertise, skills, and leadership (Scott, 1999; Burchinal et al., 2002; Grogin and Andrews, 2002; Darling-Hammond et al., 2017).

There is no doubt among policymakers and practitioners about the importance of PD, and most experts agree that needs analysis is critical to successful PD (Kirkpatrick and Kirkpatrick, 2007; Ng and Szeto, 2016). In other societies, many studies have investigated principals' PD needs (Norton and Abramowitz, 1981; Whitebook et al., 2011; Hallinger and Chen, 2015). However, few have examined the PD needs of kindergarten principals in China (Wang and Jiao, 2015; Jiao and Liu, 2022). Moreover, none have explored the private-public and rural–urban gaps in PD needs among Chinese principals. The existing studies confirmed that Chinese principals had inadequate PD opportunities. Their PD needs have been ignored (Wang and Jiao, 2015; Jiao and Liu, 2022), particularly among those private kindergartens in central and western rural areas (Wu, 2021; Qu, 2022).

## 2.3. The current study

Aiming to build a high-quality and professional principal team, the MOE launched the national Kindergarten Principal PD program in 2014. In particular, the authorities launched a national Key PD program targeting the most experienced and effective public school principals, hoping to 'exert their radiation effect' on principals' PD (Jiao and Liu, 2022). The national Key Principal program annually provides a one-month free PD program to the eight most-experienced public principals selected from each province. However, this national PD program followed the existing public-private dichotomy; thus, the rural–urban divide might have exacerbated the educational inequalities between the rich and poor. This means that public kindergartens in urban areas would get more and better PD resources than those private ones in rural areas. Therefore, one would naturally ask questions such as "are there any rural–urban and private-public gaps in Chinese principals' PD needs" and "is there a Matthew effect in PD or not?" The answers to these questions would help policymakers review the national PD program, improve the policies and practices, and eventually facilitate Chinese principals' PD. To achieve this objective, this national survey study adopted a mixed-methods approach to explore the inequalities in PD needs empirically. The following questions guided this study:

1. Are there significant rural–urban differences in PD needs among Chinese kindergarten principals?
2. Are there significant private-public differences in PD needs among Chinese kindergarten principals?
3. Are there any latent profiles of PD needs? And who needs PD the most?

# 3. Methods

## 3.1. Participants

This is a quantitative-qualitative sequential mixed-methods study, as we first conducted a national survey study and then an in-depth interview study. Classified random sampling was conducted for the national survey study. There are remarkable rural–urban and east–west gaps in social and economic development in China. The economy in eastern China is more advanced than in western and central China. To understand the real situation of PD in varying areas of China, we included 10 regions representing different parts of China. First, we randomly selected five regions representing eastern China (Beijing, Shanghai, Jiangsu, Zhejiang, Fujian) and five representing central and western China (Neimenggu, Chongqing, Xinjiang, Heilongjiang, Sichuan). Second, between July and December 2021, local teaching/research staff helped to disseminate anonymous online questionnaires to regional principals' WeChat groups (WeChat is the largest online communication app in China). Third, the kindergarten principals were invited to complete an online informed consent form, after which they received an online questionnaire via WeChat at www.wjx.cn. Finally, 3,065 participants completed the survey after answering all the questions, and the percentage of valid questionnaires was 96.67% ($n = 2{,}963$). This comprised 1,949 public and 1,014 private kindergarten principals; 1,751 worked in urban and 1,212 in rural areas. In total, 1,068 were urban public principals, 881 worked in rural public schools, 683 worked in urban private schools, and 331 worked in rural private schools. More than half (53.29%) were under 40 years old, and 84% of the participants had a degree majored in ECE. One-fifth worked in new kindergartens founded less than three years ago. Full demographic information is presented in Table 1.

In the follow-up interview study, 16 participants were sampled from the survey study to better understand the factors underlying obstacles to their PD. Four participants were randomly sampled from each group: urban public, urban private, rural public, and rural private schools. In addition, the 16 participants were invited to complete individual semi-structured interviews. After obtaining their informed consent, the interviews were conducted between January and April 2022; interviews usually lasted between 30 and 60 min and were conducted via WeChat. Their demographic characteristics are presented in Table 2.

This study was approved by East China Normal University Ethics Review Committee (HR004-2021). All data containing personal information were anonymized or stored securely to protect participants' privacy.

## 3.2. Measures

### 3.2.1. Principals' PD needs and obstacles questionnaire

This questionnaire investigated kindergarten principals' backgrounds, PD needs, and obstacles influencing their PD. It was developed and reviewed by five experts in ECE. Among them, three were university researchers in ECE, and two were practice experts; all were familiar with the principal's PD. In addition, a pilot study was conducted in a non-participating region to ensure the contents of the questionnaires were valid, clear, and easy to understand, and the completion time was reasonable. Subsequently, necessary clarifications and corresponding changes were made to refine and finalize the instruments.

The final version of the questionnaire consisted of two major parts. Part one included 11 items relating to participants' background information, including their current educational level

10.3389/fpsyg.2023.1118787

TABLE 1 Participants' demographic information ($n$=2,963).

| | Description | Participants | Percentage |
|---|---|---|---|
| Area | Eastern | 1,651 | 55.72% |
| | Central and western | 1,312 | 44.28% |
| Age | 20–30 | 356 | 12.01% |
| | 31–40 | 1,223 | 41.28% |
| | 41–50 | 1,157 | 39.05% |
| | 51 or older | 227 | 7.66% |
| Years of work experience | 3 years or less | 131 | 4.42% |
| | 4–7 years | 377 | 12.72% |
| | 8–10 years | 359 | 12.12% |
| | 11–15 years | 561 | 18.93% |
| | More than 15 years | 1,535 | 51.81% |
| Years of work experience as principal | 1–3 years | 1,160 | 39.15% |
| | 4–7 years | 726 | 24.5% |
| | 8–10 years | 436 | 14.71% |
| | 11–15 years | 308 | 10.39% |
| | More than 15 years | 333 | 11.24% |
| Major | ECE | 2,490 | 84.04% |
| | Education | 274 | 9.25% |
| | Not education-related | 189 | 6.72% |
| Current educational level | Master's degree | 95 | 3.21% |
| | Bachelor's degree | 2,248 | 75.87% |
| | College degree | 560 | 18.9% |
| | Teacher training school | 47 | 1.59% |
| | High school | 13 | 0.44% |
| Years since school established | 1–3 years | 567 | 19.14% |
| | 4–7 years | 558 | 18.83% |
| | 8–12 years | 565 | 19.07% |
| | 13–20 years | 482 | 16.27% |
| | 21 years or more | 791 | 26.7% |
| School type | Urban public school | 1,068 | 36.04% |
| | Rural public school | 881 | 29.73% |
| | Urban private school | 683 | 23.05% |
| | Rural public school | 331 | 11.17% |
| Urban–rural | Urban | 1751 | 59.1% |
| | Rural | 1,212 | 40.9% |
| Public-private | Public | 1,949 | 65.78% |
| | Private | 1,014 | 34.22% |
| Total | | 2,963 | 100% |

and the level they desired to attain through future PD programs. Part two contained 18 items scored on 5-point Likert scales ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). These items assessed kindergarten principals' PD needs and obstacles from three perspectives. First, PD needs were evaluated using eight items; examples include: 'My PD need is to improve my marketing skills and 'My PD need is to obtain a higher degree'. Second, preferred PD program content contained six items designed according to the six domains defined by the *Principals' Standards*: 'Planning the development of kindergarten', 'Creating educational culture', 'Leading care and education', 'Guiding teachers' development', 'Improving management', and 'Adapting to the environment'.

TABLE 2 Demographic characteristics of interviewees ($n$=16).

| Code | Category | Gender | Degree | Years in administrative position |
|---|---|---|---|---|
| A | Urban public kindergarten principals | Female | Bachelor's | 2 |
| B | Urban public kindergarten principals | Female | Master's | 5 |
| C | Urban public kindergarten principals | Female | Bachelor's | 3 |
| D | Urban public kindergarten principals | Female | College | 3 |
| E | Urban private kindergarten principals | Male | Master's | 7 |
| F | Urban private kindergarten principals | Female | College | 3 |
| G | Urban private kindergarten principals | Female | College | 2 |
| H | Urban private kindergarten principals | Female | Bachelor's | 12 |
| I | Rural public kindergarten principals | Female | College | 5 |
| J | Rural public kindergarten principals | Female | College | 3 |
| K | Rural public kindergarten principals | Female | College | 6 |
| L | Rural public kindergarten principals | Female | Bachelor's | 9 |
| M | Rural private kindergarten principals | Female | College | 2 |
| N | Rural private kindergarten principals | Female | College | 4 |
| O | Rural private kindergarten principals | Female | College | 3 |
| P | Rural private kindergarten principals | Female | High school | 18 |

Finally, obstacles to PD contained four items; examples include: 'The main obstacle to my PD is that the PD program contents were too theoretical' and 'The main obstacle to my PD is the inconvenient location of the PD program'.

The overall Cronbach's α coefficient for this questionnaire was 0.918. Fitness tests showed good validity: KMO = 0.922; significance probability = 0.000. A three-factor model (e.g., PD needs, preferred PD program content, and obstacles to PD) was generated for the scale using the principal-axis factoring of the Direct Oblimin method, which could explain 64.052% of the total variance, implying that the construct validity of the scale was acceptable. The eigenvalues of the three constructs are 5.052, 3.016, and 1.396, respectively. We conducted confirmatory factor analysis using 2,963 formally collected questionnaires to verify the factor structure of each dimension of the scale. The scale demonstrated an acceptable model fit, $\chi 2 = 3811.919$, df = 132, $p < 0.001$, comparative fit index (CFI) = 0.887, goodness-of-fit index (GFI) = 0.884, root of the mean square residual (RMR) = 0.06, and root mean square error of approximation (RMSEA) = 0.097. For the CFI and GFI, their values are between 0–1, with closer to 0 indicating a worse fit and closer to 1 indicating a better fit. RMSEA values less than 0.10 suggest an acceptable model fit, and RMR values of 0.08 or less than 0.1 indicate an acceptable fit.

### 3.2.2. Semi-structured interviews

Li et al. (2017) proposed the aforementioned 3A framework for ECE policy study (accessibility, affordability, accountability); it provides a reliable, comparable, appropriate, and consistent measure to assess progress in ECE policies in Asia-Pacific countries. In interviews with the 16 selected participants, we extended the framework to explore 3A problems associated with principals' PD needs based on questions such as (1) Accessibility: Is it difficult for you to access PD opportunities? (2) Affordability: Do you have adequate time and funds for PD? (3) Accountability: Was your PD program effective? Are there any relevant policies or extra funds that could improve the quality? Participants were also asked to provide further comments on the accessibility, affordability, and accountability of their PD. Following this, open-ended interview questions were posed, focusing on their PD needs. The interview protocol was developed to understand participants' views on conflicts and the major obstacles to their PD. All the interviews were conducted and audio-recorded in Mandarin Chinese, with informed consent obtained from all participants. Each interview lasted between 30 min and 1 h, depending on their availability. All interviews were transcribed into a Word document and then subjected to discourse analysis.

## 3.3. Data analysis

### 3.3.1. Quantitative data analysis

From the 3,065 completed questionnaires, 102 were deleted for the following reasons: (1) participants completed the questionnaire in less than 60 s, or (2) over 90% of the responses to scaled questions were identical. Thus, 2,963 valid questionnaires were included in the final dataset (the percentage of valid questionnaires was 96.7%). Second, we conducted two-way ANOVA tests to compare between- and within-group means (i.e., public vs. private; urban vs. rural) using SPSS 26.0. Pairwise comparison differences were considered significant at $p < 0.05$. We also employed latent profile analysis (LPA) to identify the PD needs patterns of different participants using Mplus 8.3. LPA identifies latent subpopulations within a population based on a certain set of variables (Spurk et al., 2020). It is helpful for us to identify the subgroups with different PD needs within large, heterogeneous populations in China.

### 3.3.2. Qualitative data analysis

We used two techniques to ensure the trustworthiness of the qualitative data analysis, including peer debriefing and inquiry auditing. First, in the peer debriefing stage, the first author verified that the three themes could accurately represent patterned responses and the meaning of the interview data. Second, t*he first and second authors analyzed the interview data.* Third, the last author, a professor and senior ECE researcher, acted as an inquiry auditor to ensure that qualitative data collection and analysis processes were sufficiently rigorous.

## 4. Results

### 4.1. Demographic information of participants

We used descriptive statistics (i.e., means and SDs) to summarize the demographic data of all 2,963 participants. Significant differences were found in the years of administrative experience, current degrees, and desired degrees. Most participants ($n = 1{,}886$, 63.65%) indicated that they had worked as principals for less than 7 years, while 1,160 (39.15%) reported administrative work experience of fewer than 3 years. Only 333 (11.24%) principals had more than 15 years of administrative experience. Compared with private (57.6%) and urban (62.03%) participants, more public (66.8%) and rural (66.01%) principals had less than 7 years of administrative experience. ANOVA tests showed no significant difference in administrative experience between rural–urban participants ($F = 3.389$, $p = 0.066$). However, significant statistical differences were found between public and private participants ($F = 33.650$, $p < 0.001$). As Figure 1 shows, the proportion of public principals with less than 3 years of administrative experience was nearly 10% higher than that of private principals (public = 42.33%; private = 33.04%).

More than three-quarters of respondents (75.87%) reported having a bachelor's degree. Public school participants in eastern China had the highest level of bachelor's degrees (92.77%), while those in rural private kindergartens had the lowest bachelor's degrees (41.09%). There were significant differences between rural–urban and public-private participants' current degrees (rural–urban: $\chi^2 = 79.723$, $p < 0.001$; public-private: $\chi^2 = 465.897$, $p < 0.001$) and desired degrees (rural–urban: $\chi^2 = 42.422$, $p < 0.001$; public-private: $\chi^2 = 135.209$, $p < 0.001$).

Overall, urban participants had a higher education level than rural participants. More urban participants had bachelor's degrees (77.33%) than rural ones (73.76%). Nearly 5% of urban principals had a master's degree, compared with 0.66% of rural principals. In addition, most urban participants desired a master's degree (urban = 67.85%; rural = 58.09%), while more rural principals desired a bachelor's degree through future PD (urban = 31.07%; rural = 38.45%).

As shown in Figure 2, most public participants (90.56%) had a bachelor's or master's degree. Nearly half of the private participants had a college degree or less. Over 70% of public participants desired a master's degree in the future, compared to half (51.28%) of private principals. Nearly half of the private principals (44.08%) desired a bachelor's degree, while 86.92% of public principals already had bachelor's degrees.

Generally, the public-private degree gaps (current degree: $F = 400.829$, $p < 0.001$; desired degree: $F = 130.735$, $p < 0.001$) were more distinct than those between rural–urban participants (current degree: $F = 63.554$, $p < 0.001$; desired degree: $F = 39.630$, $p < 0.001$).

### 4.2. PD needs and preferred program contents

A two-way between-groups ANOVA was conducted to compare the PD needs of rural–urban and public-private participants, and the results are presented in Table 3. The two most frequently selected PD needs were 'To improve leadership' ($M = 4.844 \pm 0.50$) and 'To improve expertise' ($M = 4.813 \pm 0.54$). There were significant urban–rural differences in the needs 'To obtain a higher degree' (rural = 4.18; urban = 4.00; $p < 0.001$) and 'To get a certificate' (rural = 4.29; urban = 4.21; $p < 0.05$). Significant differences between public-private participants were found for most items. The public participants had stronger needs for the first five items but less interest in the last three items ('To improve marketing skills', 'To obtain a higher degree', and 'To get a certificate') than private principals.

The most needed PD program content was 'Guiding teachers' development' ($N = 2{,}713$, 91.56%). There were no significant rural–urban and public-private differences in this item. The public participants had stronger needs in the first five content items, but private principals indicated a stronger need for the last item, 'Adapting to the environment'.

The two-way ANOVA revealed a significant interaction effect between rural–urban and public-private participants. The interaction effect between the four groups of kindergarten participants was statistically significant in the following items: 'To learn ECE content' ($F = 7.779$, $p < 0.005$), 'To meet other principals' ($F = 6.492$, $p < 0.05$), 'To improve marketing skills' ($F = 7.923$, $p < 0.005$), 'To get a certificate' ($F = 3.917$, $p < 0.05$), 'Leading care and education' ($F = 5.699$, $p < 0.05$), and 'Adapting to the environment' ($F = 15.370$, $p < 0.001$). In other items, the interaction effect was not statistically significant, and the effect size was small, $\eta_p^2$ (public-private) = 0.023; $\eta_p^2$ (rural–urban) = 0.005, $\eta_p^2$ (rural–urban * public-private) = 0.005.

### 4.3. Three profiles of PD needs

We conducted an LPA to explore participants' PD needs based on the two dimensions in Table 3, 'PD needs' and 'preferred PD program contents'; it yielded five models with varying numbers of latent classes. As shown in Table 4, the three-class solution was demonstrated to have the best model fit. The values of the Akaike information criterion (AIC), Bayesian information criterion (BIC), and adjusted BIC (aBIC) decrease continuously as the number of classes increases. As the number of classes changes from three to four, the values of AIC, BIC, and aBIC demonstrate a relatively slight change. Table 4 presents this three-profile model, which was selected because it had the highest entropy (0.92), lower AIC (8,499.489) and BIC values (8,559.428), a slightly lower aBIC value (8527.654), and a statistically significant LMRT value ($p < 0.001$). The parsimony and interpretability of the three profiles were also considered. Based on the results of all model fitting indexes, the three-profile model was supposed to be a perfect model.

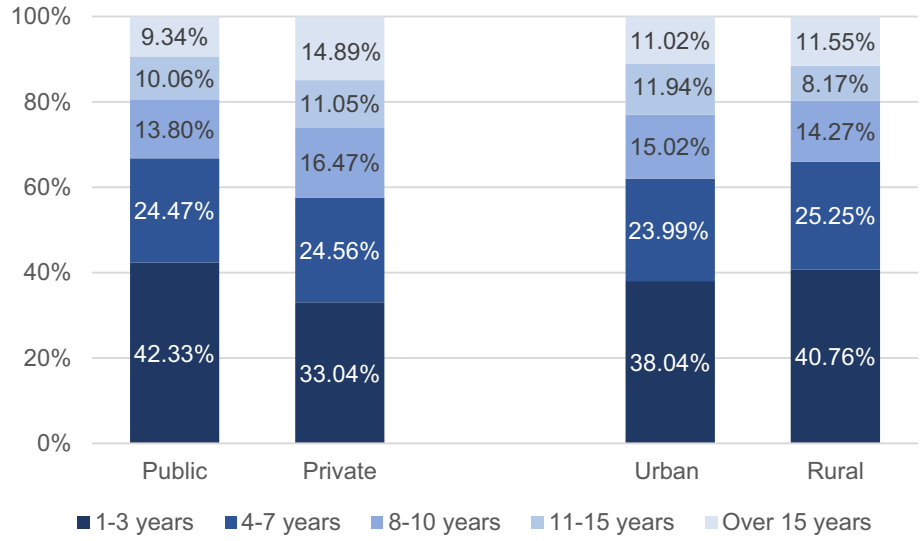


FIGURE 1
Years of administrative experience among rural, urban, public, and private principals.

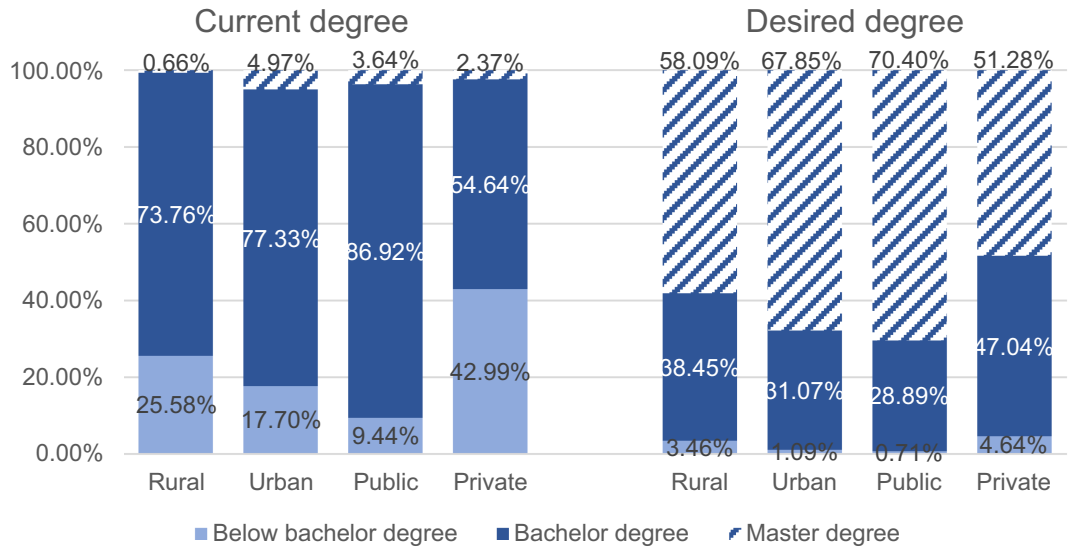


FIGURE 2
Current and desired degrees of different kindergarten principals ($n$=2,963).

As shown in Figure 3, 7.5% ($n$ = 222) of participants were classified into Profile 1, 22.2% ($n$ = 657) as Profile 2, and 70.3% ($n$ = 2,084) as Profile 3. First, Profile 1 was labeled 'Low PD needs' as they had the lowest scores on eight 'PD needs' items ($M$ = 3.140 ± 0.35) and six 'preferred PD program contents' items ($M$ = 3.262 ± 0.558). Second, Profile 2 was labeled 'Medium PD needs' (PD needs: $M$ = 4.069 ± 0.242; preferred PD program contents: $M$ = 3.859 ± 0.561). Finally, Profile 3 was labeled 'High PD needs' (PD needs: $M$ = 4.892 ± 0.173; preferred PD program contents: $M$ = 4.517 ± 0.569).

A chi-square analysis was conducted to investigate the differences among the demographic variables of the three profiles. As shown in Table 5, the three profiles were differentiated by age ($p$ < 0.01), years of administrative work experience ($p$ < 0.01), current degree ($p$ < 0.05), desired degree ($p$ < 0.01), years since their kindergarten was established ($p$ < 0.01), and whether they worked in public or private kindergartens ($p$ < 0.01). No significant differences were found between rural–urban participants.

### 4.3.1. Low PD needs profile

Participants in Profile 1 had the lowest scores on these items; this group was named the "Low PD needs" group, with the least number of participants; only 222 (7.5%) principals belonged to this group. The major features of the low PD needs group were: being over 50 years old (15.86%), having more than 15 years of administrative experience

TABLE 3 Two-way ANOVA: PD needs and preferred PD program contents.

| Factor | Indicator/Item | Public-Private | Urban–Rural | Public-Private * Urban–Rural | | Urban | Rural |
|---|---|---|---|---|---|---|---|
| | | *F* | *F* | *F* | | M±SD | M±SD |
| PD needs | To improve expertise | 22.927** | 3.743 | 2.709 | Public | 4.85 ± 0.47 | 4.84 ± 0.50 |
| | | | | | Private | 4.78 ± 0.59 | 4.70 ± 0.69 |
| | To improve leadership | 21.897** | 5.586* | 0.045 | Public | 4.89 ± 0.38 | 4.85 ± 0.52 |
| | | | | | Private | 4.80 ± 0.55 | 4.75 ± 0.63 |
| | To learn ECE content | 19.395** | 8.423** | 7.779** | Public | 4.82 ± 0.52 | 4.81 ± 0.54 |
| | | | | | Private | 4.78 ± 0.60 | 4.65 ± 0.75 |
| | To meet researchers | 38.647** | 6.876** | 1.585 | Public | 4.79 ± 0.53 | 4.75 ± 0.62 |
| | | | | | Private | 4.66 ± 0.72 | 4.56 ± 0.79 |
| | To meet other principals | 6.199* | 3.128 | 6.492* | Public | 4.63 ± 0.71 | 4.65 ± 0.71 |
| | | | | | Private | 4.63 ± 0.72 | 4.50 ± 0.83 |
| | To improve marketing skills | 3.379 | 5.744* | 7.923** | Public | 4.48 ± 0.90 | 4.50 ± 0.94 |
| | | | | | Private | 4.65 ± 0.76 | 4.46 ± 0.91 |
| | To obtain a higher degree | 16.846** | 13.891** | 1.275 | Public | 3.90 ± 1.36 | 4.14 ± 1.22 |
| | | | | | Private | 4.16 ± 1.22 | 4.29 ± 1.06 |
| | To get a certificate | 12.211** | 2.556 | 3.917* | Public | 4.11 ± 1.18 | 4.27 ± 1.10 |
| | | | | | Private | 4.36 ± 1.10 | 4.34 ± 1.04 |
| Preferred PD program contents | Planning the development of kindergarten | 13.356** | 0.954 | 3.252 | Public | 4.21 ± 0.77 | 4.23 ± 0.76 |
| | | | | | Private | 4.15 ± 0.81 | 4.06 ± 0.81 |
| | Creating educational culture | 38.678** | 0.314 | 2.276 | Public | 4.42 ± 0.85 | 4.46 ± 0.80 |
| | | | | | Private | 4.25 ± 1.01 | 4.18 ± 1.01 |
| | Leading care and education | 69.844** | 2.363 | 5.699* | Public | 4.42 ± 0.65 | 4.45 ± 0.66 |
| | | | | | Private | 4.25 ± 0.77 | 4.14 ± 0.85 |
| | Guiding teachers' development | 5.639* | 0.880 | 3.304 | Public | 4.39 ± 0.74 | 4.41 ± 0.72 |
| | | | | | Private | 4.37 ± 0.77 | 4.29 ± 0.78 |
| | Improving management | 8.211** | 0.240 | 2.551 | Public | 4.34 ± 0.73 | 4.37 ± 0.71 |
| | | | | | Private | 4.30 ± 0.73 | 4.24 ± 0.78 |
| | Adapting to the environment | 7.543** | 0.509 | 15.370** | Public | 3.92 ± 0.95 | 4.09 ± 0.91 |
| | | | | | Private | 4.17 ± 0.86 | 4.05 ± 0.95 |

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

TABLE 4 Latent profile analysis: model-fit statistics of the potential models ($n$=2,963).

| Model | AIC | BIC | Adjusted BIC | *p*-LMR | Entropy | Percentage in profiles |
|---|---|---|---|---|---|---|
| C = 2 | 9,440.148 | 9,482.106 | 9,459.864 | 0.0000 | 0.886 | 0.195/0.805 |
| **C = 3** | **8,499.489** | **8,559.428** | **8,527.654** | **0.0001** | **0.920** | **0.075/0.222/0.703** |
| C = 4 | 8,122.724 | 8,200.645 | 8,159.339 | 0.1211 | 0.917 | 0.043/0.092/0.652/0.213 |
| C = 5 | 7,683.837 | 7,779.740 | 7,728.902 | 0.1662 | 0.930 | 0.036/0.059/0.587/0.127/0.191 |

AIC, Akaike information criterion; BIC, Bayesian information criterion; p-LMR, the value of *p* of the Lo–Mendell–Rubin likelihood ratio test; Bold values indicate the most suitable model (three-profile model) based on the results of all model fitting indexes.

(12.91%), having a high school degree (23.08%), working in private schools (9.27%), and working at schools established for 8–12 years (9.03%). This result shows that experienced and relatively senior private principals with high degrees working at kindergartens established for 8–12 years are more likely to have low PD needs.

### 4.3.2. Medium PD needs profile

The major features of the medium profile group were as follows: being over 50 years old (41.41%), having over 15 years of administrative work experience (28.83%), having a master's degree (28.42%), working in a public school (23.91%), and working at schools established for

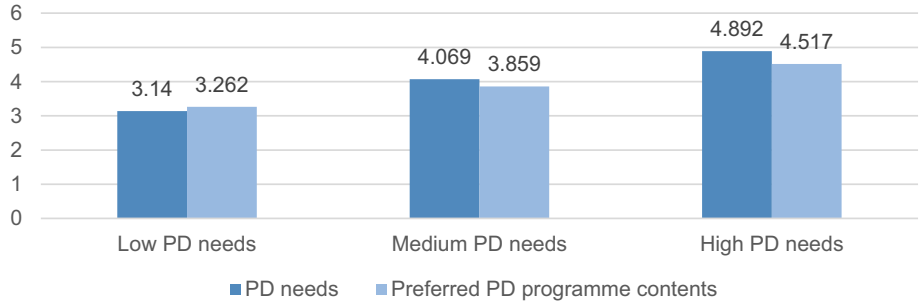


FIGURE 3
Mean scores of PD needs and preferred PD program contents across three profiles.

8–12 years (22.65%). This result indicates that veteran public kindergarten principals with master's degrees over 50 years old and working at kindergartens founded 8–12 years ago tend to have medium PD needs.

### 4.3.3. High PD needs profile

The major features of the high PD needs group included: being in the 20–30 years age group (80.34%), having less than 3 years of administrative experience (76.98%), having a bachelor's degree (70.91%), desiring a master's degree (75.85%), working in a private school (71.89%), and working at schools established for less than 3 years (76.54%). This result indicates that novice principals at new schools with bachelor's degrees and desiring master's degrees are likelier to have high PD needs.

## 4.4. Obstacles to PD

As shown in Table 6, the ANOVA test revealed significant differences between rural–urban and public-private principals regarding the obstacles to their PD. The public principals reported more severe concerns about PD program content and training style ($M = 3.85$ and $M = 3.87$, respectively) than those in private schools ($M = 3.71$ and $M = 3.64$, respectively).

Both public and urban principals reported higher concerns about PD training style than those in private and rural schools (public = 3.87; urban = 3.84; private = 3.64; rural = 3.71). Generally, urban principals valued their time and cared more about the training styles and locations of PD than principals in rural areas. However, the interaction effect between the kindergarten type and the region was not statistically significant among the four items.

## 4.5. Interviews: the 3A problems in principals' PD

To understand other factors that facilitate or hinder principals' PD needs, we analyzed in-depth interviews using the 3A framework based on accessibility, affordability, and accountability perspectives.

### 4.5.1. Accessibility

We defined 'accessibility' based on whether principals could easily access PD opportunities. All urban public participants stated that they could easily attend PD programs twice a year, while rural public participants only attended once or twice yearly. However, seven of the eight private participants felt it was hard to attend the PD program even once a year, especially those in rural private schools. In addition, participants F and N bluntly described in-service PD opportunities as 'non-existent'. The following statements support this:

> *"Three years ago, I attended a PD session to get a principal certificate as the policy required. Since then, I have never had any opportunities for PD. There were many PD opportunities for public principals but nothing for us." (F, urban private principal).*
>
> *"I do need to improve my expertise, management, and degree. I faced so many challenges. I only have a college degree. Oh! Half of the teachers have higher degrees than me. But I did not hear about any PD opportunities this year." (N, rural private principal).*

In summary, the public-private gap in accessibility was remarkable. Most private principals could not attend appropriate and conveniently located PD programs, though they felt a strong need to improve their degrees, leadership, or expertise. Some participants were stressed, anxious, and even embarrassed about not having appropriate opportunities for PD.

### 4.5.2. Affordability

Affordability was defined as whether principals could easily afford the fees and time involved in pursuing PD programs. Most PD programs provided by local authorities were free for public principals. Even public principals in rural areas stated that their fees for PD programs could be reimbursed. However, half of the public participants complained that they could hardly find the time for PD programs. Their high workload contributed to a tendency among principals to avoid in-service PD opportunities, as confirmed by principal A:

> *"I do not have time for PD programs. Too much workload! I prefer short-term programs, like one or two days in the summer break. The national Key Principal program lasts for one month! How can I find 30 days to leave my position? It's hard for me to find half a day away." (A, urban public principal).*

While the public participants complained about their busy schedules, private participants believed they had neither time nor funds for PD. For example, M, a rural private principal, stated:

TABLE 5 Demographic characteristics according to the three profiles.

| Variable | Profile1 n=222 | Profile2 n=657 | Profile3 n=2084 | $\chi^2$ | *P* | Cramer's V |
|---|---|---|---|---|---|---|
| Age | | | | 142.998 | 0.000** | 0.155 |
| 20–30 | 6.18% | 13.48% | 80.34% | | | |
| 31–40 | 5.40% | 17.42% | 77.19% | | | |
| 41–50 | 8.47% | 26.10% | 65.43% | | | |
| ≥ 51 | 15.86% | 41.41% | 42.73% | | | |
| Years of administrative experience | | | | 69.072 | 0.000** | 0.108 |
| ≤3 | 5.34% | 17.67% | 76.98% | | | |
| 4–7 | 8.82% | 20.39% | 70.80% | | | |
| 8–10 | 6.88% | 28.44% | 64.68% | | | |
| 11–15 | 7.47% | 27.27% | 65.26% | | | |
| ≥16 | 12.91% | 28.83% | 58.26% | | | |
| Current degree | | | | 20.005 | 0.010* | 0.058 |
| Master's degree | 9.47% | 28.42% | 62.11% | | | |
| Bachelor's degree | 6.54% | 22.55% | 70.91% | | | |
| College degree | 10.18% | 20.00% | 69.82% | | | |
| Teacher's secondary school | 12.77% | 21.28% | 65.96% | | | |
| High school | 23.08% | 7.69% | 69.23% | | | |
| Desired degree | | | | 100.136 | 0.000** | 0.130 |
| Master's degree | 4.70% | 19.45% | 75.85% | | | |
| Bachelor's degree | 11.98% | 27.33% | 60.69% | | | |
| College degree | 20.00% | 21.82% | 58.18% | | | |
| Teacher's secondary school | 16.67% | 16.67% | 66.67% | | | |
| Number of years kindergarten has been established | | | | 28.389 | 0.000** | 0.069 |
| ≤3 | 4.06% | 19.40% | 76.54% | | | |
| 4–7 | 6.99% | 21.68% | 71.33% | | | |
| 8–12 | 9.03% | 22.65% | 68.32% | | | |
| 13–20 | 8.30% | 19.29% | 72.41% | | | |
| ≥21 | 8.72% | 25.92% | 65.36% | | | |
| Urban or rural | | | | 2.238 | 0.327 | 0.027 |
| Urban | 7.08% | 22.96% | 69.96% | | | |
| Rural | 8.09% | 21.04% | 70.87% | | | |
| Public or private | | | | 14.778 | 0.001** | 0.071 |
| Public | 6.57% | 23.91% | 69.52% | | | |
| Private | 9.27% | 18.84% | 71.89% | | | |

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

> *"My training will not be reimbursable like those in public schools. If my boss asked me to attend the PD program, she might cover the fee, but she assumes I do not need any training. Besides, I am too busy."*

Thus, the affordability gap between public and private participants was also significant. All the private participants expressed their hope for funds or bursaries for further PD and stated that they desperately need to improve their leadership and expertise.

### 4.5.3. Accountability

Accountability refers to how the PD program should be accountable for improving the principal's professionalism. For example, although some participants (A and D) indicated that they found the PD program to be fruitful, other participants complained about the quality of previous PD programs, in which lectures or presentations were used to transmit theoretical knowledge; participants were treated as passive recipients of ready-made

TABLE 6 Two-way ANOVA: obstacles to PD.

| Title | Public/ Private*Urban/ Rural | Public | Private | *F* | Urban | Rural | *F* |
|---|---|---|---|---|---|---|---|
| | *F* | M+SD | M+SD | | M+SD | M+SD | |
| PD content is too theoretical | 1.480 | 3.85 ± 1.07 | 3.71 ± 1.17 | 12.67** | 3.81 ± 1.11 | 3.79 ± 1.10 | 1.64 |
| Boring PD style | 0.561 | 3.87 ± 1.15 | 3.64 ± 1.28 | 24.83** | 3.84 ± 1.21 | 3.71 ± 1.19 | 9.63** |
| Inconvenient PD time | 1.580 | 3.55 ± 1.15 | 3.47 ± 1.17 | 5.91* | 3.58 ± 1.14 | 3.45 ± 1.18 | 12.839** |
| Inconvenient PD location | 0.007 | 3.37 ± 1.18 | 3.35 ± 1.17 | 0.33 | 3.40 ± 1.17 | 3.31 ± 1.19 | 4.411* |

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

knowledge rather than active agents, as the following statement shows:

> *"I would suggest a more practical PD program for us in rural areas. It seems like all the PD programs are designed for urban principals. It is not practical for my school. I'd like to visit other rural kindergartens instead of listening to a talk." (L, Rural public principal).*
>
> *"Well, it was boring. The trainers often lacked management experience and taught some theories which seemed useless to us. The trainer gave us some evaluation forms. But I do not think it'll work. I have attended many PD programs. Most of them were the same. Someone [in the government] should monitor the PD programs." (B, Urban public principal).*

In summary, most respondents were dissatisfied with the current quality of PD programs. The survey results verified this finding. Most participants suggested that there should be a more consistent evaluation rubric for PD programs and that the government should monitor the effectiveness of PD programs.

# 5. Discussion

This first national survey of the PD needs of Chinese kindergarten principals has confirmed the rural–urban and private-public gaps, verified by the follow-up interview studies. This section will discuss these findings and their implications for PD policymaking and practical improvements.

## 5.1. The rural–urban gap in PD needs

This study found a significant rural–urban gap in PD needs among Chinese kindergarten principals. This is supplementary to a previous study suggesting that principals in rural areas may have specific PD needs (Salazar, 2007). In particular, this study found that more rural principals were novices within the first three years of their leadership position (Shoho and Barnett, 2010). Due to the rapid expansion of ECE, the number of kindergartens in China climbed by 94%, from 150,400 in 2010 to 291,700 in 2021 (Gov. CHN, 2011–2022). These new kindergartens were mainly located in rural areas, and thus, more novice principals emerged in rural kindergartens. Accordingly, the novice principals in this study reported strong PD needs. This finding is consistent with the existing findings: novice principals experience more challenges in building and sustaining community relationships and thus need more PD training (Bloom, 1989; Hargreaves, 2005; Meyer and Patuawa, 2022).

In addition, this study found a significant difference between rural and urban participants' educational levels. More urban participants had bachelor's and master's degrees than those in rural areas; in particular, the urban–rural ratio of master's degrees was 8:1. This widening urban–rural gap in educational levels has made rural principals (the disadvantaged group) need PD training more. As a growing body of research suggests that principals' educational level is a strong predictor of overall ECE quality (Helburn et al., 1995; Bloom, 2004; Vu et al., 2008), it is expected that the quality of rural kindergartens is far behind their urban counterparts (Li et al., 2019; Qian, 2019). Therefore, it is urgently needed to provide more PD opportunities for rural principals and to upgrade their educational levels to promote educational equity in China.

## 5.2. The public-private gap in PD needs

This study found a significant public-private gap in the PD needs of Chinese kindergarten principals. In addition, this study also found that the public-private degree gap was larger than the rural–urban gap. Half the private kindergarten principals had not completed a bachelor's degree, and the principals in rural private kindergartens had the lowest educational level and became the most disadvantaged group. This finding is consistent with a previous study (Yin, 2022). In addition, private kindergartens in rural China have a limited budget for extra expenditures such as PD programs. Although the *Outline* targeted increasing government responsibilities in supporting private kindergartens, private principals struggled to get appropriate PD opportunities, which would have enlarged the public-private gap.

## 5.3. The 'Matthew effect' in Chinese kindergarten principals' PD

This study found that more than 70% of principals had high PD needs, and most of them were novice principals in new private kindergartens in rural China. Unfortunately, they had few resources and opportunities for PD under the current ECE structure in China: private-public dichotomy and rural–urban divide. In contrast, those principals in urban public kindergartens had more PD opportunities even though

they did not need them. These findings jointly indicated a 'Matthew Effect' in Chinese principal PD: the rich would get more, whereas the poor would get less. This 'Matthew Effect' implies that the current PD policy in China is dysfunctional or ineffective in narrowing the urban–rural and public-private gaps; instead, the policy has enlarged the gaps and resulted in the current challenges that have limited the offer of free PD programs to all principals. Previous studies have reported that very few novice and private principals could participate in the national principal PD program (Xing and Yang, 2018). When their 'sisters' (the principals of urban public kindergartens) attend the 'ball' (PD training) organized by the 'prince' (the educational authorities), 'Cinderella' (the principals of rural private kindergartens) is crying in the kitchen. However, no policy amendments have been made, and the bureaucratic policymakers continue to train the most experienced and effective principals, leaving 'Cinderellas' still crying. Suppose this tragedy continues; thus, the rural and private principals with high PD needs cannot access PD programs. In that case, the public-private and urban–rural gaps in kindergartens will continue to widen. The policymakers should act now to stop this 'Matthew Effect."

### 5.4. Limitations

This is the first national survey to evaluate kindergarten principals' PD needs in China. However, this study has three major limitations that should be addressed in future studies. First, this study adopted the cross-sectional design that surveyed Chinese principals at one study time point. This design does not allow us to precisely measure the changes in principals' PD needs, especially between the time points before and after the PD training. Future studies should preferably consider longitudinal studies to deepen the understanding of Chinese principals' evolving changes in PD needs. Second, this study employed a newly developed questionnaire asking Chinese principals to self-report their PD needs. This self-reported survey is vulnerable to socially desirable bias, which is the respondents' tendency to over-report their needs and thus interferes with the interpretation of average tendencies and individual differences. To overcome the bias, future studies should establish a triangulation of methods such as surveys, interviews, document analysis, and field notes. Third, this study only surveyed Chinese principals about their PD needs, leaving other stakeholders such as teachers, parents, and education officers uninvolved. This single-informant study is likely to suffer from an informant bias, which negatively impacts the validity of the findings. Future studies should involve early childhood teachers, parents, and educational officers to provide triangulated perspectives and consolidated evidence.

### 5.5. Implications

The findings of this study have some implications for policymaking: (1) Accessibility: all principals, whether public or private, rural or urban, should have equal access to PD programs; (2) Affordability: free PD programs should be provided to those rural and private principals; and (3) Accountability: the PD programs should be improved to enhance their efficiency and attractiveness. Accordingly, more efforts should be made to solve the '3A' problems facing Chinese principals' PD, along with increasing the fiscal budget in the private PD sector and monitoring the quality of PD. This will promote the sustainability and social justice of ECE. Furthermore, integrated policies and efficient PD programs should be developed and tailored to the PD needs of different kindergarten principals. The educational authorities should act now to ensure that all principals achieve high-quality PD and stop the 'Matthew effect' in the PD and the entire ECE field.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by East China Normal University Ethics Review Committee (HR004-2021). The patients/participants provided their written informed consent to participate in this study.

## Author contributions

YQ: methodology, writing—original draft preparation, and resources. SZ: investigation and data curation. HL: conceptualization, writing—review and editing, and supervision. All authors contributed to the article and approved the submitted version.

## Funding

This research was funded by the Program of Humanities and Social Sciences, Ministry of Education, China, funding number 21YJAZH066; and Shanghai Educational Legislative Talent Program, funding number 2020JYFXR040.

## Acknowledgments

The authors want to acknowledge all the participants who made their anonymized data available for research.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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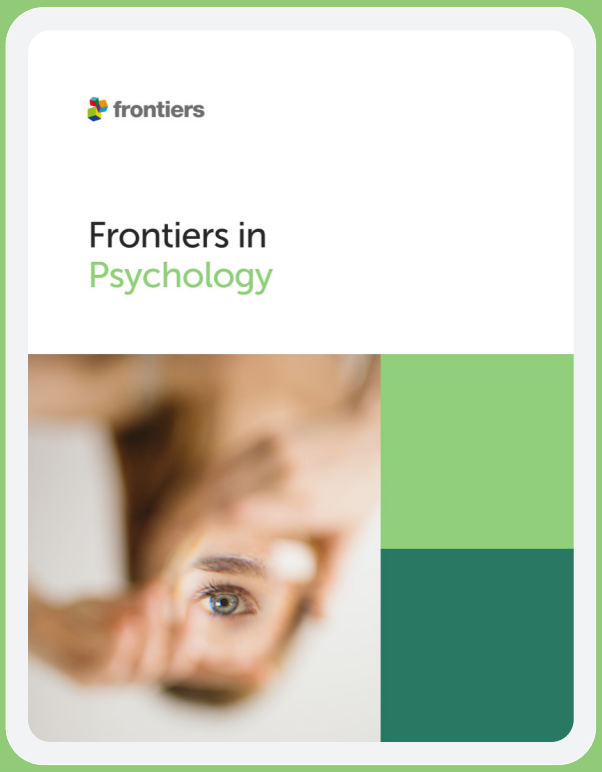


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