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Original Paper

Study of the Educational Quality of Public and Private Kindergartens through the PDCA Model

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Abstract

This study uses the Plan-Do-Check-Act (PDCA) cycle as the hypothetical model. Multigroup analysis with public and private kindergartens as the group variables is conducted via this hypothetical model to explore the differences in its goodness-of-fit between public and private kindergartens. The research samples are selected from kindergartens in counties and cities in Taiwan, Penghu, Kinmen, and Matsu and include principals, directors (administrative personnel), teachers, and preschool educators, selected with proportional stratified random sampling. The sample structure of the formal questionnaire is as follows: 253 public kindergartens, accounting for 32.56%; and 524 private kindergartens, accounting for 67.44%. This study therefore finds that (1) the goodness-of-fit of the overall model for both public and private kindergartens is good; (2) the results of a measurement invariance test demonstrate measurement constancy and cross-group validity; (3) regarding measurement invariance in the public and private kindergartens, the structural model shows measurement constancy and cross-group validity; (4) for "private" kindergartens, the impact of "Do" on "Action" is higher than for "public" kindergartens, and there is no constancy or cross-group validity. Accordingly, this study advocates the following: (1) subsidizing the software and hardware construction and personnel costs of private kindergartens to improve the quality of kindergarten education; (2) promoting relevant policies such as the "public-private cooperation model" to emphasize the decommodification of early childhood education (ECE); and (3) implementing the "community-orientation" and "localization" of kindergartens to improve and strengthen their connections with families and communities.

Keywords: kindergarten education quality, education quality indicators, PDCA cycle, structural equation model

1. Introduction

The term evaluation is rather familiar to people engaged in the education and teaching field. When teachers perform their professional responsibilities, evaluation activities are necessary and have paramount importance in driving learning progress (Syarwani & Syahrani, 2022). In fact, evaluation is the basis for the accreditation and certification of educational institutions. Quality plays an important role in improving the internal quality of education. According to the needs and conditions of the educational environment, education quality assurance plays a key role in every education plan, and the effective realization of quality strongly supports a successful level of learning. Schools are responsible for providing and contributing to the fulfilment of standards, while educational assessment standards include the mechanisms, procedures and testing tools for assessing student learning outcomes; these standards are critical to ensuring the quality of education (Hidayah & Syahrani, 2022). Therefore, through

educational evaluation, various effective scientific methods and technologies must be systematically used to collect qualitative and quantitative information, and these must be compared with predefined evaluation criteria to determine the value, advantages and disadvantages of educational objects; these results are thus used as a reference for educational decision-making (Lin, 2008).

Hall (2013) believes that evaluation should not be just a technical activity of data collection and analysis; indicators of kindergarten education quality should be constructed. Effective school evaluation applies its results to the administrative operation of a school and promotes interaction and communication among teachers, administrators, teachers and students or between parents and teachers to determine the direction of school development and achieve common goals. In addition, evaluation can assist a school in making progress in comparisons and competitions with other schools that have been evaluated, an important process of school self-management and reflection (Nevo, 1994; Hopkins, et al., 2008). Xu (2012) has pointed out that in the future, the promotion of the kindergarten professional accreditation system together with the government's various supporting measures for the growth of the education and teaching profession can assist kindergartens in their transformation toward professional early childhood education (ECE). Such professional kindergartens should have a healthy and safe environment, professional personal, abundant education and childcare resources, an operating system that continuously improves its quality, and a culture that supports the common growth and mutual care of the children, teachers, parents, and community to improve the education quality of kindergartens.

Relevant literature has shown that preschool educators in different types of schools (the background variable) have different views on professional accreditation evaluation. Ding (2017), Wu (2013) and Zhou (2015) all point out that preschool educators have no significant differences in their cognition levels or opinions on "types of kindergartens". Cai (2012) also indicates no significant difference in the effect of the teacher background variable "public and private" kindergartens on the future improvement of kindergarten evaluation. Some studies have shown that preschool educators exhibit significant differences based on the type of school, while other studies have shown that these views are not significantly different. Accordingly, we explore the best, most simple model of the kindergarten professional accreditation evaluation indicators constructed by Shen (2018), the Plan-Do-Check-Act (PDCA) model. That is, we use the PDCA model to evaluate kindergarten education quality, and we further investigate whether this model is suitable for different sample groups. Therefore, the purpose of this study is as follows:

1. To understand the goodness-of-fit of the PDCA model in terms of the education quality indicators (EQIs) of different groups of kindergartens (public and private).

2. To explore the measurement invariance of the PDCA model based on the EQIs of different groups of kindergartens (public and private).

3. To compare and analyze the differences in the structural coefficients of the PDCA model in terms of the EQIs of different groups of kindergartens (public and private).

2. Literature review

In many early childhood programs, there are many different interest groups (or stakeholders) that have their own views on quality. For example, program administrators, teachers, parents, community leaders, and child development experts can never forget their children. A judgment of quality can focus on many things, such as basic standards (e.g., physical space, food, hygiene, and nutrition of members), activity and learning resources (e.g., toys, textbooks), quality of adult-child relationships, flexibility in the working patterns of parents, and cost-effectiveness (Woodhead, 1998). There are many different latent quality criteria that are closely related to faith-related objectives and program functions. These beliefs, in turn, are formed through different perspectives on childhood and child development, different cultural models and personal values. Therefore, it is important to construct a quality model (Pence, & Moss, 1994) that can accommodate diverse perspectives. In this literature review, we briefly define education quality assurance, explore the implementation of a kindergarten evaluation system, review the PDCA cycle, and reveal the views within public and private kindergartens on the evaluation system.

1. Kindergarten education quality

(1) The connotation of kindergarten education quality

Kindergarten education quality assurance is an important part of ensuring that ECE serves as an important part of children's development of skills and acquisition of knowledge, enabling kindergartens to provide high-quality education quality and experience. Its purpose is to promote children's educational, social, cultural, psychological and comprehensive development (Obaid, 2022). Therefore, by improving the quality of kindergartens, we can ensure that children receive high-quality ECE.

(2) Effective ECE quality

Effective quality assurance is the goal pursued by all excellent educational institutions. The purpose of internal quality assurance is to support academic objectives, e.g., by ensuring the appropriateness of degree classification and the validity of academic quality information. The cycle of an internal quality assurance system includes the following stages: assessing the education quality implemented by educational institutions according to national education standards; formulating a quality improvement plan that meets the requirements of a school's work plan; implementing quality construction in the management and learning processes of educational institutions; monitoring and evaluating the implemented quality execution process; and determining new standards and developing quality improvement strategies based on monitoring and evaluation results (Hidayah & Syahrani, 2022).

Kindergarten education is critical for children's educational development and represents their first attempts to acquire knowledge and learn the basics of life and the world. Against this background, the global education system has begun to pay attention to concepts such as preschool education, kindergarten education, inclusive kindergarten, game-based education system, and music-based education (Obaid, 2022). In addition, as the pressure of family care continues to increase, governments worldwide are paying more attention to the urgent need to provide care services to infants aged 0-3 years. According to United Nations Sustainable Development Goal 4.2, "equal access to quality preschool education", governments globally are working hard to ensure that by 2030 all children have access to high-quality early childhood development, care and preschool education to prepare them for primary school enrolment (United Nations, 2023).

(2) Factors affecting the education quality

Mengstie (2023) notes that preschool teachers have emphasized the importance of developmentally appropriate practices (DAPs) for children's development and learning but that external factors, such as lack of investment in kindergarten teachers and related resources, large class sizes, lack of parent support, or management problems affect DAPs and reduce ECE quality. Therefore, the ministry of education, policy-makers, teacher training institutes, and school administrators should design strategies that enable preschool teachers to practice their strong belief in DAP in the classroom.

In addition, Hurley et al. (2022) point out that the usability of early children education and care (ECEC) is affected by its availability, revealing that children's facilities in more disadvantaged areas are fewer, whereby the socioeconomic status of a community can affect the availability of ECEC. Fort (2020) also indicates that children from socioeconomically disadvantaged backgrounds have developmental disadvantages because they are less likely to experience a high-quality nurturing environment at home; however, these developmental disadvantages can be alleviated by receiving ECEC. In contrast, children from socioeconomically advantaged families have various resources that promote their development, whether internal or external. Therefore, improving ECEC quality is very important for the development of all children.

In addition, in the context of early childhood, some studies have used ecological methods to investigate ECE quality, from the microscopic scale to the macroscopic scale. Hunkin and Grieshaber (2023) propose five important principles for the construction of the "theory of quality ecology"; these explain the complex, multidimensional and contextual characteristics of ECEC "quality" in the literature as follows: quality can be cocreated; quality is multidimensional; generally, the elements of process quality and structural quality coexist and can expand; "quality" is influential; and the quality is emerging and spontaneous. Urban (2012) has applied the critical ecological perspective to professionalism in early

childhood education to keenly capture an in-depth understanding and realization of the "everyday micro and macro politics". Through an in-depth understanding of the life experiences of educators, Dalli et al. (2012) have thus enriched the existing knowledge, directions, and theories of ECE from the ecological point of view, demonstrating the reciprocity in the ECE profession and its dimensions of territoriality and inclusiveness.

2. PDCA cycle

Different organizations use different research methods, methods and tools to implement quality management and programs for continuous quality improvement. These programs often have different names or labels, such as total quality management (TQM), six sigma, business process reengineering (BPR), operational excellence, or business excellence. Regardless of name, however, every organization must select and combine different relevant methods, tools, and techniques in the execution process. Most of these tools, methods and techniques are widely available and easy to understand, such as the PDCA cycle or Deming's circle. Experts use these advanced technologies and methods to solve problems and execute actions (Sokovic et al., 2010).

In this process, the actual result of execution is compared to the focal goal, whereby the difference between the two is obtained. If this difference increases, corrective measures are taken, and the PDCA cycle (Figure 1) is performed repetitively for continuous improvement (Basu, 2004). This is also called "Deming's circle", after W. E. Deming. Another variation of the PDCA model is the Plan-Do-Study-Act (PDSA) model, defined in the literature (Sokovic et al., 2007; Ministry of Education, 2012; Zheng, 2008) as follows:

(1) Plan: In preplanning, the policies and objectives are determined, and the activity plan is proposed.

(2) Execution (Do): Implementation of the proposed plan.

(3) Check: Review, i.e., summary of the results of plan implementation, focusing on the effects and identifying the relevant problems.

(4) Action: Implementation of solutions, i.e., making improvements based on the revealed problems to appropriately popularize and standardize any successful experience and to solve any problems that arise to prevent their recurrence. For any unresolved problems, the next PDCA cycle can be executed to ensure continued improvement.

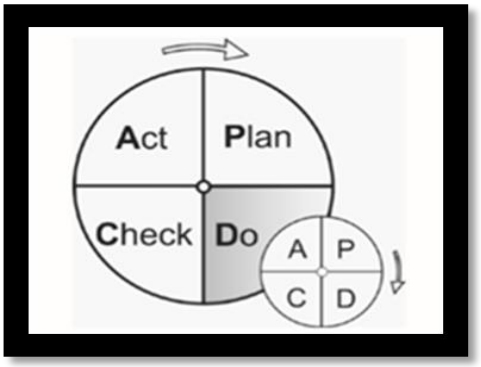

Figure 1. PDCA cycle (Basu, 2004)

Note. "Implementing Quality – A Practical Guide to Tools and Techniques," by Basu, R. 2004. London: Thomson Learning.

In the action or implementation stage, a mini-PDCA cycle may be performed until the focal issue is resolved (Sokovic et al., 2010). After the plan is established and the official implementation starts, many factors are often found that were not considered in plan formulation. Therefore, these factors should be

recorded so that there is a record to follow in any subsequent check, and attention should be given to whether each original goal is met (Lee, 2015).

Sokovic et al. (2010) have found that the application of the PDCA cycle is more effective than adopting the right first time" method. Using the PDCA cycle means constantly looking for better improvement methods to effectively complete a job and manage a program, and this can involve both temporary and permanent improvement actions. The purpose of temporary actions is to obtain results through the actual addressing and solving of problems. On the other hand, permanent improvement actions include investigating and removing the root causes of problems, thus fulfilling the continuous improvement process. The PDCA cycle is suitable for internal quality assurance and includes the following questions: What purpose do we want to achieve? How do we know that a change is an improvement? What changes can we make for improvement?

In addition, Gidey et al. (2014) suggest that the PDCA model can be widely used in the following situations: as a continuous improvement model; when a new improvement project is about to be implemented; in the developmental period when designing new or improved processes; when performing repetitive work processes; and when implementing any changes. The PDCA cycle is not just a tool, it can embed a concept of the continuous improvement process into organizational culture (Figure 2). The most important task occurs in the "Act" stage after the completion of a project because when the cycle restarts, the determined improvement actions can be continued (Sokovic et al., 2010). Therefore, during the implementation of a plan, the original plan may be amended at any time and then reviewed afterward.

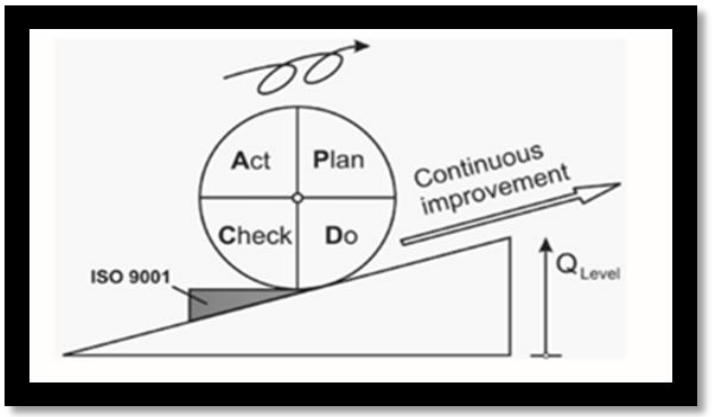

Figure 2. PDCA cycle for continuous improvement

Note. "Quality Improvement Methodologies –PDCA Cycle, RADAR Matrix, DMAIC and DFSS," Sokovic, MD, Pavletic, D., & Pipan, KK 2010. *Journal of Achievements in Manufacturing Engineering*, *43*(1), 476-483.

A preschool education professional quality system aims to ensure the professional quality of preschool education and the achievement of preschool education objectives through systematic operations. Since the results of the preschool education process should be accountable to its users (the children who grow within it, the society in which these children grow up, and the parents of these children), it is usually impossible to start over once problems are discovered (Ministry of Education, 2011). Therefore, PDCA is a cyclic and orderly process, which underscores that under the concept of systemization, the PDCA process must be followed; moreover, its operation should be assured in a continuous cycle to solve any problems that arise and prevent their recurrence. Yang (2014) have pointed out that continuous improvement represents the continuous search for methods that can improve the operation of the process. If the kindergarten education supervision and administrative team are actively engaged in continuous improvement, they can train the preschool education team to use the PDCA cycle to solve any problems.

This study uses the PDCA framework to test the constancy of public and private kindergartens for EQIs. When using the PDCA cycle, standards must be set; if there are differences in the implementation process, these problems must be identified, resolved, and reviewed. Hence, inspections and corrections can be conducted at any time. The PDCA cycle is thus a model that simultaneously operates, revises, and advances standards.

3. Methods

The above literature review shows that the education quality of kindergartens can be improved through evaluation. This study uses the PDCA model as the focal EQI framework to explore the views of public and private kindergartens on the evaluation system. However, since the preschool educators at different types of schools have different views on the EQIs, it is important to understand the goodness-of-fit of the EQIs adopted in this study among different types of schools.

1. Research objects

In this study, kindergartens in counties and cities in Taiwan, Penghu, Kinmen, and Matsu are sampled. The principals, directors (administrative personnel), teachers, and preschool educators of these kindergartens are the subjects of the survey. In this study, 15% of the kindergartens in southern Taiwan, central Taiwan, northern Taiwan, and eastern Taiwan (including off-shore islands) are randomly selected according to their proportions and based on the sizes of their kindergartens (< 60 students, 61-200 students, and > 201 students); hence, proportional stratified random sampling is performed. Among total of 1,000 questionnaires sent out, 798 are returned, a recovery rate of 79.8%. Among them, 777 are valid, and 21 are invalid questionnaires with incomplete answers. The sample structure of the formal questionnaire is as follows: 253 public kindergartens, accounting for 32.56%; and 524 private kindergartens, accounting for 67.44%.

2. Research tools and variables

This study uses the best simple model (shown in Figure 3) with the "Kindergarten Professional Accreditation Evaluation Indicators" constructed by Shen (2018) as the research tool for multigroup comparison. In terms of convergent validity, the second-order model of the tool in this study has 11 sublevels, and the component reliability and factor loadings of each sublevel are mostly greater than the standard of 0.7. The average variance extraction (AVE) and the square of the multivariate correlation coefficient (R^2) values are also larger than the standard threshold. Therefore, most of the tools in this study have convergent validity. In terms of discriminant validity, the confidence interval values among the tool dimensions do not contain 1. Thus, most of the dimensions of the second-order model of the tool in this study have discriminant validity.

There are a total of 33 questions in the questionnaire. A five-point Likert scale of "completely important", "mostly important", "ordinary importance", "partially important", and "slightly important" is used. The subjects are invited to answer each question according to their perceived "level of importance" of the indicators. The levels of the 33 questions are "Plan", "Do", "Check" and "Action". These four levels form the four latent variables in the measurement model in this study, as shown in Figure 3.

"Plan" is defined as follows: The kindergarten could create a cooperation and learning atmosphere in the classroom through child-centered curriculum planning. There are 7 questions.

"Do" is defined as the implementation of the kindergarten plan through the leadership of the principal, the ability to carry out effective teaching, the management of various teaching resources and facilities, and the establishment of a diverse family and community network, which promote the implementation of the plan. The sublevels are leadership role, effective teaching, resource utilization and resource network, with 4 questions, 2 questions, 4 questions and 3 questions, respectively.

"Check" is defined as follows: The preschool educators and parents, through communication and interaction, can understand the learning performance of children and perform learning evaluations of them. The sublevels are parent-teacher interaction, learning performance, and learning evaluation, with 3 questions, 2 questions, and 2 questions, respectively.

"Action" is defined as follows: Kindergartens conduct improvement and guidance based on the problems

that arise during inspection. The sublevels are continuous improvement and study guidance, with 2 questions and 4 questions, respectively.

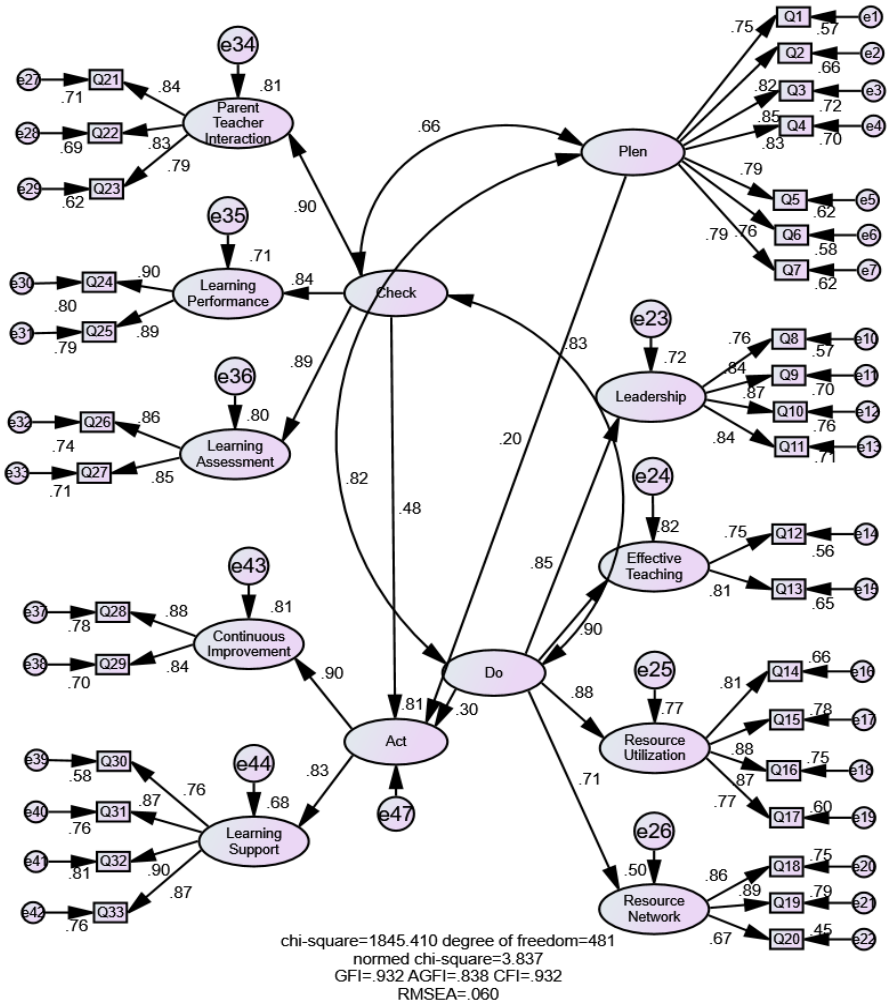

Figure 3. Second-order factor model of kindergarten EQIs

3. Research design

The aim of verification via a multigroup structural equation model (SEM) is to assess whether a model suitable for one sample group is suitable for other, different sample groups, that is, to evaluate whether the proposed theoretical model in this study is equivalent or invariant in terms of parameters across different sample groups. The attributes of the variables for different sample groups are usually discrete variables (nominal variables or ordinal variables). If the results of a multigroup SEM suggest that the model is suitable and can be accepted, this indicates that the discrete variable has a moderating effect on the proposed hypothetical model (Wu, 2013). This study thus investigates the constancy, the cross-group validity, and the path differences of the PDCA cycle model via an overall SEM of public and private kindergartens.

4. Data processing and analysis

(1) Multiple group comparative analysis

In multigroup analysis, measurement invariance must be confirmed before the relationships among the latent variables in the structural model can be investigated (Renhao Li & Minning Yu, 2016). Measurement invariance ranges from relaxed to strict. This study builds five nested models to verify the

degree of goodness-of-fit. Their descriptions are as follows: (1) Unconstrained: no parameter constriction; (2) Measurement weights: the factor loadings are set to be equal; (3) Structure weights: the path coefficients of the additional groups are equal; (4) Structural covariances: the added covariance matrices (including variances and covariances) are equal; and (5) Structural residuals: the numbers of variances of the added endogenous latent variables are equal (Wu, Zhang, 2010). First, the overall hypothesis diagram is drawn, then, calculation is performed to illustrate the standardized result diagram. Next, in stage 2, the assumption model diagram of each group is drawn; after calculation, the standardized structure diagram is then presented.

Wu and Zhang (2010) indicate that in the comparison of nested results, the baseline model with unconstrained parameters (model A) is assumed to be true. The null hypothesis and the alternative hypothesis for the nested model test are as follows:

1. Null hypothesis: the simplified model (model B) with constrained parameters is true (equivalent to the baseline model with unconstrained parameters), that is, constrained model (model B) = unconstrained model (model A).

2. Alternative hypothesis: the simple model (model B) with constrained parameters is not true (not equivalent to the baseline model with unconstrained parameters), that is, constrained model (model B) ≠ unconstrained model (model A).

If the difference $\Delta\chi^2$ (this difference is the difference in the chi-square value between models B and A) between the two models reaches significance, then the null hypothesis that "the simple model with constrained parameters is true" is rejected, and the alternative hypothesis that "the simple model with constrained parameters is not true" is accepted. Similar to single-group analysis, the differences in the chi-square values $\Delta\chi^2$ across the nested models in multigroup analysis is affected by the sizes of the samples in each group and could easily reach the designated significance level ($p < .05$). Therefore, four goodness-of-fit statistics that are less affected by the model complexity should be considered, namely, ΔNFI, ΔIFI, ΔRFI, ΔTLI. Hence, for the difference test results among nested models, if the absolute value of the difference of the above four statistics is < .05, there is not enough evidence to reject the null hypothesis, i.e., there is no difference between the simple model (model B) with constrained parameters and the baseline model with unconstrained parameters (model A) (Wu & Zhang, 2010).

(2) Comparison of the coefficients of the structural models in different types of schools

In two-stage multigroup analysis using an SEM, the first stage is the goodness-of-fit test of the single-sample model, and the second stage is the constancy test of the path coefficients. Only after the goodness-of-fit test of the SEM of the individual group is the constancy test of the multigroup structural model performed. SEM analysis and evaluation are performed to determine whether the goodness-of-fit is sufficient. In addition, whether the difference in chi-square value ($\Delta\chi^2$) between Model 1 and Model 2 is significant is tested. If this test result is not significant, then the constriction of "path coefficient constancy" is valid. Furthermore, once it is proven that the interference effect among different types of schools exists and is significant, the path changes based on the interference effect, which still needs to be tested to determine whether the preschool educators at different types of schools have significantly different views of EQIs (Chen & Wang, 2013).

Once an effective EQI model is obtained, it can be used to develop a baseline model of the constancy of the different types of schools. This base model must be verified according to different types of schools, as measurement tools are usually group-specific in terms of their operation methods. Therefore, these baseline models usually do not have to be consistent across groups (Chen & Wang, 2017).

5. Results

1. Measurement invariance test

(1) Overall sample goodness-of-fit test

Table 1 shows that the indicators of the goodness-of-fit for the overall model of the different types of schools all fulfill the criteria (including the unconstrained model and the four constrained models), indicating that the goodness-of-fit levels in the five models are all at an acceptable level. In this case, five

nested models are used to perform the constancy test of goodness-of-fit.

Regarding the simple goodness-of-fit index, the AIC values of the five competing models are in the range of 4895.617-4915.803, with the structural residuals being the smallest, indicating that the consistency of the hypothetical models in the different types of schools is good. The EVIC values fall in the range of 3.156-3.169, with the structural residuals being the smallest, indicating that the differences among the hypothetical models in the different types of schools are small. That is, although the five hypothetical models are all approximately suitable, after comparison, the most simple model, the "structural residuals", is the best; hence, it is chosen because this hypothetical model has the best goodness-of-fit with the sample data.

Table 1. The goodness-of-fit indexes of the overall measurement models of the different types of schools (including the unconstrained model and the four constrained models)

Goodness-of-fit index		**Goodness-of-fit standard or Threshold value**	**Unconstrained**	**Measurement weights**	**Structure weights**	**Structural covariances**	**Structural residuals**
Absolute goodness-of-fit index	χ^2	*p*>.05	4725.803 *p*=.000	4727.577 *p*=.000	4731.006 *p*=.000	4736.461 *p*=.000	4737.617 *p*=.000
	GFI	>.90 good >.80 acceptable	.834	.834	.834	.834	.834
	AGFI	>.90 good >.80 acceptable	.824	.825	.825	.826	.826
	RMR	<.05 good	.026	.026	.026	.026	.026
	SRMR	<.05 good <.08 acceptable	.0663	.0663	.0667	.0678	.0681
	RMSEA	<.05 good <.08 Reasonable	.036	.036	.036	.036	.035
Incremental goodness-of-fit index	TLI	>.90	.923	.923	.923	.924	.924
	CFI	>.90	.923	.923	.923	.923	.923
Simple goodness-of-fit	PGFI	>.50	.787	.790	.792	.794	.795
	PNFI	>.50	.890	.893	.895	.898	.899
	PCFI	>.50	.925	.929	.930	.934	.934
Competitiveness index	AIC	the smaller the better	4915.803	4905.577	4903.006	4896.461	4895.617 (min)
	ECVI	the smaller the better	3.169	3.163	3.161	3.157	3.156 (min)

(2) Nested model constancy test

For the nested model analysis results in Table 2, first, if the model with unconstrained parameters is true, the *p* value of the chi-square increase in "Measurement weights" is .939 ($p > .05$), i.e., the .05 significance level is not reached, this indicates that the null hypothesis is accepted and that the alternative hypothesis is rejected. The characteristics of the models with unconstrained parameters and with constrained parameters are considered the same. In this case, the absolute differences in the incremental goodness-of-fit indexes are used for the comparison of nested models. As Table 2 shows, the absolute changes or the increases ΔNFI, ΔIFI, ΔRFI, and ΔTLI in the incremental goodness-of-fit indicators are all less than .05, and the absolute ΔCFI is less than .01, indicating the acceptance of the null hypothesis and the rejection of the alternative hypothesis. Therefore, when the model with unconstrained parameters is true and supported, the model with constrained parameters is also true.

Next, if the "Measurement weights" model is true, the *p* value of the chi-square increase for "Structure weights" is .330 ($p > .05$), i.e., the .05 significance level is not reached, this indicates that the null hypothesis is accepted and the alternative hypothesis is rejected. This means that the characteristics of the models with unconstrained parameters and with constrained parameters are considered the same. In this case, the absolute differences in the incremental goodness-of-fit indexes are used for the comparison of nested models. As Table x shows, the absolute changes or the increases ΔNFI, ΔIFI, ΔRFI, and ΔTLI in the incremental goodness-of-fit indicators are all less than .05, and the absolute ΔCFI is less than .01, indicating that the null hypothesis is accepted and the alternative hypothesis is rejected. Therefore, when the model with unconstrained parameters is true and supported, the model with constrained parameters is also true.

Furthermore, if the "Structure weights" model is true, and the *p* value of the chi-square increase in "Structural covariances" is .487 ($p > .05$), i.e., the .05 significance level is not reached, this indicates that the null hypothesis is accepted and the alternative hypothesis is rejected. This means that the characteristics of the models with unconstrained parameters and with constrained parameters are considered the same. In this case, the absolute differences in the incremental goodness-of-fit indexes are used for the comparison of nested models. According to Table 2, the absolute changes or the increases ΔNFI, ΔIFI, ΔRFI, and ΔTLI in the incremental goodness-of-fit indicators are all less than .05, indicating that the null hypothesis is accepted, and the alternative hypothesis is rejected. Therefore, when the model with unconstrained parameters is true and supported, the model with constrained parameters is also true.

Finally, if the "Structural covariances" model is true, the *p* value of the chi-square increase in the "Structural residuals" is .282 ($p > .05$),), i.e., the .05 significance level is not reached, this indicates that the null hypothesis is accepted and the alternative hypothesis is rejected. This means that the characteristics of the models with unconstrained parameters and with constrained parameters are considered the same. In this case, the absolute differences in the incremental goodness-of-fit indexes are used for the comparison of nested models. According to Table x, the absolute changes or the increases ΔNFI, ΔIFI, ΔRFI, and ΔTLI in the incremental goodness-of-fit indicators are all less than .05, indicating that the null hypothesis is accepted, and the alternative hypothesis is rejected. Therefore, when the model with unconstrained parameters is true and supported, the model with constrained parameters is also true.

Table 2. Nested model analysis table of the overall structure model of the different types of schools

Test conditions	DF	CMIN ($\Delta\chi^2$)	P	NFI Delta-1	IFI Delta-1	RFI rho-2	TLI rho-2	CFI rho-2
Model with unconstrained parameters is true								
"Measurement weights"	6	1.774	.939	.000	.000	.000	.000	.000
The "Measurement weights" model is true								
"Structure weights"	3	3.429	.330	.000	.000	.000	.000	.000
The "Structure weights" model is true								

"Structural covariances"	6	5.454	.487	.000	.000	.000	.000	.000
The "Structural covariances" model is true								
"Structural residuals"	1	1.157	.282	.000	.000	.000	.000	.000
Standard value or critical value				<.05	<.05	<.05	<.05	<.01

Based on the above results, the goodness-of-fit of the overall model among both public and private kindergartens is good, while **the measurement invariance test shows** measurement constancy and cross-group validity.

2. Comparison of structural model coefficients

This study performs second-stage multigroup analysis via an SEM and a constancy test of the multigroup SEMs constructed by the two groups of samples from public and private schools to understand whether different types of kindergartens can mediate the original model.

(1) Single-sample model goodness-of-fit test (stage 1)

Table 3 lists the results of the regression coefficients of each path. It shows that all the regression weights (measurement weights) in the measurement model are significant and that the three regression weights (structure weights) in the structural model are also significant. As Chen and Wang (2017) note, if the regression weights estimated in a model are all significant, the intrinsic quality of the model is quite good.

Table 3. Unstandardized regression weights for public and private kindergartens

Observation variable		**Latent variable**	Estimate	SE	CR	P
Action	<---	Check	.488	.069	7.085	***
Action	<---	Plan	.213	.061	3.494	***
Action	<---	Do	.351	.106	3.298	***
Effective teaching	<---	Do	.980	.058	16.968	***
Resource network	<---	Do	1.003	.063	15.960	***
Leadership as	<---	Do	1.000			
Study counseling	<---	Action	.719	.037	19.692	***
Continuous improvement	<---	Action	1.000			
Resource utilization	<---	Do	1.097	.060	18.277	***
Parent-teacher interaction	<---	Check	1.000			
Learning performance	<---	Check	1.108	.033	33.558	***
Learning evaluation	<---	Check	.965	.042	23.127	***
Q10	<---	Leadership as	1.089	.043	25.261	***
Q8	<---	Leadership as	1.000			
Q11	<---	Leadership as	1.048	.043	24.237	***

Q9	<---	Leadership as	1.025	.043	24.033	***
Q12	<---	Effective teaching	1.000			
Q13	<---	Effective teaching	1.059	.051	20.651	***
Q15	<---	Resource utilization	1.040	.036	28.921	***
Q14	<---	Resource utilization	1.000			
Q16	<---	Resource utilization	1.035	.037	28.315	***
Q17	<---	Resource utilization	.906	.038	24.118	***
Q24	<---	Learning performance	1.000			
Q27	<---	Learning evaluation	.988	.037	26.729	***
Q26	<---	Learning evaluation	1.000			
Q29	<---	Continuous improvement	.923	.034	27.019	***
Q28	<---	Continuous improvement	1.000			
Q33	<---	Study counseling	1.196	.042	28.793	***
Q31	<---	Study counseling	1.108	.033	33.558	***
Q32	<---	Study counseling	1.194	.039	30.265	***
Q19	<---	Resource network	1.046	.037	28.322	***
Q18	<---	Resource network	1.000			
Q20	<---	Resource network	.689	.034	20.468	***
Q25	<---	Learning performance	.957	.025	38.152	***
Q30	<---	Study counseling	1.000			
Q22	<---	Parent-teacher interaction	1.035	.037	27.643	***
Q21	<---	Parent-teacher interaction	1.000			
Q23	<---	Parent-teacher interaction	.866	.034	25.599	***
Q1	<---	Plan	1.000			
Q2	<---	Plan	1.175	.050	23.733	***
Q3	<---	Plan	1.165	.047	24.794	***
Q4	<---	Plan	1.140	.047	24.373	***
Q5	<---	Plan	.984	.043	22.833	***
Q6	<---	Plan	1.107	.050	22.011	***
Q7	<---	Plan	1.090	.048	22.752	***

To compare the differences in the structural coefficients of the latent variables between public and private kindergartens, measurement invariance in the model should first be established to ensure that the

subsequent comparison of the structural coefficients is meaningful. Therefore, the goodness-of-fit test of the single-sample model is first conducted. Table 4 shows that each goodness-of-fit index in the overall samples reaches the relevant threshold. The GFI and the NFI scores of the public kindergarten samples are .797 and .860, respectively, and both are close to the thresholds. Following Chen and Wang (2013) and Zhang (2013), in general, under the principle of majority indicators, the goodness-of-fit of the three sample models reaches the acceptable level. In this case, we can enter the second stage of the structure weight constancy test. In this study, competition model III of the EQIs is thus the starting point for verifying the models in public and private kindergartens to ascertain whether an effective baseline model suitable for different types of schools can be obtained.

Table 4. The goodness-of-fit index for single-sample models for public and private kindergartens

Goodness-of-fit index	Goodness-of-fit standard or critical value	Overall sample	Public	Private
χ^2	p>.05	1846.360 p=.000	1049.665 p=.000	1372.81 p=.000
GFI	>.90 good; >.80 acceptable	.861*	.797	.827*
RMSEA	<.05 good; <.08 reasonable	.060*	.068*	.069*
TLI	>.90	.925*	.911*	.904*
CFI	>.90	.932*	.918*	.913*
NFI	>.90	.910*	.860	.882
IFI	>.90	.932*	.919*	.913*
CFI	>.90	.932*	.918*	.913*
PNFI	>.50	.831*	.785*	.805*
Normed chi-square		3.831	2.178	3.456

*indicates meeting the standard

(2) Structure weight constancy test (stage II)

After establishing a number of multigroup SEMs, analysis can be performed. These results are listed in Table 5. Interference models II, III, and IV are the baseline models with constrained parameters added: model I (chi-square value: 3003.186, df = 1027), model II (chi-square value: 3007.842, df = 1028), model III (chi-square value: 3003.255, df = 1028), and model IV (chi-square value: 3010.816, df = 1028). Analysis of the differences among the baseline model and interference models II, III, and IV is performed.

1. The chi-square difference ($\Delta\chi^2$) between constancy model II and baseline model I is 4.656, which is greater than the chi-square value (3.84) of these two models when the difference in the degree of freedom is 1 (Δdf =1), and the .05 significance level is reached, indicating significant differences between Models II and I. That is, the assumption of the constancy model that the paths of two groups are equal is invalid, and the interference (moderating) effect of "public" and "private" kindergartens exists in model II, indicating that the model does not have measurement constancy or cross-group validity and that the path changes need to be examined. In other words, preschool educators at different types of schools exhibit significant differences in their management goal model. However, a ΔCFI of .000, which is less than the standard of .01, indicates that the two models do not have any significant difference (Cheung, & Rensvold, 2002; Little, 2013). Therefore, although the above difference is statistically significant, in practice, the two models show no difference in the influence of “Check” and “Action” on “Action”, indicating constancy and cross-group validity.

2. The chi-square difference ($\Delta\chi^2$) between constancy Model III and baseline Model I is 1.262, which is greater than the chi-square value (3.84) of the two models when the difference in the degree of freedom is 1 (Δdf =1), and the .05 significance level is reached, indicating that Model III and Model I do not have significant differences. That is, the assumption of the constancy model that the paths of two groups are equal is valid, and the interference (moderating) effect of "public" and "private" kindergartens do not exist in model III. The ΔCFI is .000, which is less than the standard of .01, indicating that there is no difference in the impact of "Plan" on "Action" between the two models. Thus, there is constancy and cross-group validity.

3. The chi-square difference ($\Delta\chi^2$) between constancy Model IV and baseline Model I is 7.63, which is greater than the chi-square value (3.84) of the two models when the difference in the degree of freedom is 1 (Δdf =1), and the .05 significance level is reached, indicating that there are significant differences between Model IV and Model I. That is, the assumption of the constancy model that the paths of two groups are equal is invalid, and the interference (moderating) effect of "public" and "private" kindergartens exists in model IV, indicating that the model does not have measurement constancy and cross-group validity. In other words, preschool educators at the different types of schools show significant differences in terms of the influence of "Do" on "Action". However, a ΔCFI of .000, which is less than the standard of .01, indicates that the two models do not demonstate a significant difference in the influence of "Do" on "Action" and that there is no constancy and cross-group validity. Therefore, the coefficients of the effects of "Do" on "Action" within the different types of schools must be further compared.

Table 5. Constancy test results for the path coefficients of "public kindergarten" vs. "private kindergarten"

Model	χ^2	***df***	**CFI**	$\Delta\chi^2$	Δdf	**ΔCFI**
Baseline Model I	3003.186	1027	.904	-	-	-
Constancy model II Check ⟶ Action	3007.842	1028	.904	4.656	1	.000
Constancy model III Plan ⟶ Action	3004.448	1028	.904	1.262	1	.000
Constancy Model IV Do ⟶ Action	3010.816	1028	.903	7.63	1	.001

The coefficients of the effect of "Do" on "Action" in constancy Model IV between the public kindergartens and the private kindergartens are then further compared. Table 6 shows that the path coefficient of private kindergartens (.54) is higher than that of public kindergartens (.49). In other words, for private kindergartens, the effect of "Do" on "Action" is stronger than for public kindergartens.

Table 6. The interference path coefficients for public kindergartens vs. private kindergartens

Path	Public	Private
	Estimated value	Estimated value
Constancy Model IV Do ⟶ Action	.49	.54

6. Conclusions and suggestions

Based on the above results, this study provides the following conclusions and suggestions:

1. Conclusions

(1) The structural model proposed in this study has a valid goodness-of-fit for both public and private kindergartens.

Multigroup analysis is performed via the structural model proposed in this study with school type as a group variable. The regression weights estimated in the proposed structural model proposed all reach significance, indicating that the intrinsic quality of the model is quite good. To understand the differences in the goodness-of-fit between public and private kindergartens, first, the overall hypothesis model diagram and the hypothesis model diagram for each group are drawn. Then, calculation is performed, and the standardized result diagram is presented. These results show that the indicators of the goodness-of-fit of the unconstrained model and the four constrained models in the public and private kindergartens all meet the thresholds, indicating that the goodness-of-fit values of these five models all reach the acceptable level.

(2) The structural model proposed in this study shows measurement constancy and cross-group validity in the measurement invariance test of public and private kindergartens.

Next, the constancy test is performed on the nested models, i.e., the "Unconstrained", "Measurement weights", "Structure weights", "Structural covariances", "Structural covariances" and "Structural residuals" models, and the null hypothesis and the alternative hypothesis are compared. The absolute ΔNFI, ΔIFI, ΔRFI, and ΔTLI are all less than .05, indicating that the null hypothesis is accepted and that the alternative hypothesis is rejected.

In the goodness-of-fit index test of the unconstrained model and the four constrained models, for the optimal school type, the "Structural residuals" model is the best.

(3) For "public" and "private" kindergartens, there is no significant difference in the influences of "Plan" and "Check" on "Action" based on constancy and cross-group validity.

This study shows that "public" and "private" kindergartens both attach importance to the influence of "Plan" and "Check" on "Action", which is the core element of the PDCA cycle. That is, for the PDCA cycle, the standards must be first set, and then, during their implementation, if there is any gap in the actual data, it is necessary to evaluate and to take improvement actions.

(4) For "private" kindergartens, the impact of "Do" on "Action" is higher than for "public" kindergartens, as there is no constancy or cross-group validity.

The results of the path coefficient constancy test and the interference path coefficient analysis show that for preschool educators in "private" kindergartens, the impact of "Do" on "Action" is higher than in "public" kindergartens, indicating that "private" kindergartens attach more importance to and more often solve and improve the problems that arise during the implementation of their plans or programs to prevent their recurrence. The PDCA cycle is a model that is based on quality responsibility and operates, corrects and progresses simultaneously.

2. Suggestions

Based on the above conclusions, we propose the following suggestions:

(1) Subsidize the software and hardware construction and personnel costs of private kindergartens to improve the quality of ECE

This study shows that "public" and "private" kindergartens both attach importance to the influence of "Plan" and "Check" on "Action". However, the main difference between private and public kindergartens is that the latter is subsidized by the government in terms of their hardware and software, whereby private kindergartens always face financial constraints when aiming to make improvements that provide children with a better and safer environment.

Therefore, this study suggests that appropriate fee standards should be set based on the their urban-rural disparity and the sizes of schools and that subsidies for software and hardware construction and personnel costs should be provided to ensure that private kindergartens can improve their quality of ECE through "Plan", "Check" and “Action”, thereby increasing the willingness of private kindergartens to participate in the program of the "quasipublicization of private kindergartens".

(2) Promote relevant policies such as the “public-private cooperation model” with an emphasis on the decommodification of ECE

This study shows that “private” kindergartens pay more attention to the influence of “Do” on “Action”. Under the impact of subreplacement fertility levels, to increase their enrollment rates, private kindergartens must pay more attention to diversified learning activities for young children, and private kindergartens must also pay more attention to the “Do” aspect to address subreplacement fertility. However, if the “Do” of education is commercialized, it could exceed the learning burden of young children and increase the education costs for parents, which cannot improve the learning and development of young children.

We suggest that the government should strengthen the subsidies for relevant policies in the “public-private cooperation model”, such as the “quasipublicization of private children”, “one-stop childcare”, “nonprofit kindergartens”, or “foresight kindergartens”, design appropriate teaching activities, provide parents with an educational subsidy to achieve the multiple benefits of sending young children to kindergartens and reduce the burden on parents and the childcare industry, act as an “anchor”, emphasize the decommercialization of ECE, and, thus, gently and slowly bring about “qualitative changes” in Taiwan’s kindergarten market.

(3) Promote the implementation of "community-orientation" and "localization" of kindergartens and improve and strengthen their connections to families and communities

In recent years, amid the impact of subreplacement fertility levels, private kindergartens have had to address their survival and competition with one another. This study also shows that for “private” kindergartens, the impact of “Do” on “Action” is stronger than for “public” kindergartens. Both public and private kindergartens should attach importance to “Do” to improve education quality. During the “Do” stage, the original plan may be amended at any time and then reviewed afterward with the aim of building a high level of competitiveness and improving service quality.

The impact of “Do” on "Action” cannot be ignored. This study suggests that public and private kindergartens can create learning cultures in classrooms, families and communities through active leadership, effective teaching and learning activities and training, the use of resources, and the establishment of networks. Kindergartens should establish a multichannel cooperation model of emotional exchange and information interaction with parents to provide them with the latest parenting information. Kindergartens in any community can jointly assist their community in establishing and developing a community education network and exploit their educational function to form regional preschool education centers that share resources between kindergartens and communities. They can thereby effectively mediate any conflict between parents and teachers, continuously improve the quality of education, jointly cultivate young children’s development, and provide learning guidance to young children.

3. Limitations of this study

First, this study only tests the constancy of the focal public and private kindergarten groups with regard to kindergarten EQIs. In the future, two other types of kindergartens, nonprofit organizations and quasipublic kindergartens, could be incorporated to further evaluate the constancy and cross-group effects. From an ecological point of view, the constancy of different school locations with regard to the educational quality evaluation indicators in the PDCA cycle could also be tested.

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