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Digital learning for preschools: Validation of basic ICT competence beliefs of preschool teachers in Hong Kong and the Philippines

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Abstract
With technology integration efforts expanding to early childhood education globally, assessing preschool teachers' technological competence beliefs is imperative. However, most existing tools measuring teachers' information and communication technology (ICT) competence beliefs focused on primary through secondary grades. This study examined the factorial validity, reliability, and measurement invariance of the Basic ICT Competence Beliefs (BICB) questionnaire among 209 preschool teachers in Hong Kong and the Philippines. Confirmatory factor analyses supported the original nine-factor structure over plausible alternative models. All factors showed good reliability (α=0.83 to 0.91) and theoretically meaningful factor intercorrelations. Multigroup CFA results supported the measurement invariance of the scale. Specifically, the results demonstrated the configural, metric, scalar, and strict invariance across cultural groups. Findings provide further validity for the BICB as a psychometrically sound instrument for assessing preschool teachers' ICT competence beliefs within and across contexts. The BICB can help identify teacher strengths and needs, guide professional development, and evaluate technology integration efforts in early childhood education in Asia.

Keywords Preschool teachers · ICT competence beliefs · Factorial validity · Measurement invariance

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1 Introduction

The advent of Information and Communication Technologies (ICT) in early childhood education (ECE) has been a transformative force, reshaping pedagogical practices and learning environments. The global shift towards online learning has further accelerated this transformation due to the COVID-19 pandemic (Barbara-Sanchez et al., 2022). This led to the growing reliance on digital tools in early education, reflecting a paradigm shift from traditional teaching methods to technology-enhanced learning experiences (Aditya et al., 2022; Hu & Yelland, 2019). With the proliferation and development of different mobile and tablet applications as teaching aids, there is a critical need for preschool teachers to not only master foundational ICT skills but also to develop a strong competence and confidence in employing these technologies effectively in their classrooms. The combination of fast digital transformation and the expected and immediate transition to online classes fell largely onto teachers' shoulders (Barbara-Sanchez et al., 2022; Ihmeideh & Al Maadadi, 2018).

According to international organizations like OECD (2015) and UNESCO (2023), technology adoption is rapidly increasing in early childhood settings worldwide. However, despite this, a significant research gap persists in understanding how these competencies are perceived and developed among preschool teachers in varied cultural contexts, especially in Asian regions like Hong Kong and the Philippines. While existing research, such as the work of Rubach and Lazarides (2021), has primarily focused on Western contexts, there is a notable lack of studies examining teachers' ICT competence beliefs in Asian educational settings. This research gap is particularly critical given the unique cultural and educational dynamics in these regions, which can significantly influence the integration and efficacy of ICT in early childhood education. The work of Kurent and Avsec (2023) underscores the importance of considering systems thinking and ICT self-concept in the context of sustainable and digital curriculum development, which may manifest differently across cultural and contextual boundaries.

Addressing this gap, our study aims to validate and adapt the Basic ICT Competence Beliefs (BICB) questionnaire (Rubach & Lazarides, 2019) for preschool teachers in Hong Kong and the Philippines. This endeavor is not only crucial for understanding the nuances of ICT integration in these specific cultural contexts but also for contributing to the global discourse on the role of technology in early childhood education. The study's findings are expected to offer insights into the multidimensional aspects of ICT competence beliefs in diverse educational settings, aiding in the development of more effective teacher training programs and educational policies tailored to the unique needs of these regions. Moreover, by exploring the ICT competence beliefs in the wake of the pandemic's push towards digital education (Barbara-Sanchez et al., 2022), this research will provide valuable perspectives on the evolving landscape of early childhood education in the digital age.

2 The need to assess preschool teachers' ICT competence beliefs

In the early childhood setting, the role of ICT has become indispensable for children's better learning experience (Aditya et al., 2022). Teachers perceive that ICT at the preschool level is suitable (Yurt & Cevher-Kalburan, 2011) and have expressed the relevance of incorporating ICT in their teaching (Dong, 2018b), which is further emphasized in recent sustainable curriculum reforms (Kurent & Avsec, 2023). Teachers also shared that promotions on the use of ICT at the early childhood level should be increased (Aditya et al., 2022).

As the importance of ICT integration in ECE classrooms becomes more appreciated, extant literature focused on conducting workshops and training programs to boost teachers' ICT knowledge and skills (i.e., Dardanou & Kofoed, 2019; Dong, 2014; Johnston et al., 2020). Apart from lack of funding as a constraint (Yang & Hong, 2022), the perception and attitude of teachers towards the use of ICT in the classroom and the possible challenges they may encounter have been found to also play a role in ICT integration in education (Dong, 2018b). In line with this, various empirical evidence showed that to successfully integrate ICT in teaching and learning, it is essential for teachers to be confident in applying ICT in their pedagogical practices (i.e., Dong, 2018b; Fraillon et al., 2020; Petko et al., 2018). According to Rubach and Lazarides (2021), applying the assumption of the expectancy-value theory of achievement motivation (This theory emphasizes the importance of competence-related beliefs and self-efficacy to be motivated and achieve) (Eccles & Wigfield, 2020 [as cited in Rubach & Lazarides, 2021]), improving teachers' confidence in skills and knowledge of ICT will more likely endorse ICT integration in their teaching methods. Therefore, it is vital to assess ECE teachers' ICT competence beliefs.

3 Assessing preschool teachers' ICT competence beliefs

Different studies have developed and validated questionnaires that measure preservice and in-service teachers' ICT competence beliefs. However, most of the questionnaires were based on the framework of technological pedagogical and content knowledge (TPACK) introduced by Mishra and Koehler (2006). These mostly focused on the relationship between teachers' ICT competence beliefs and ICT-related skills in teaching (Rubach & Lazarides, 2021). There were also assessments that measured teachers' ICT competence beliefs based on specific tasks (Herzig & Martin, 2018), while others developed a more generic questionnaire covering different pedagogical tasks (i.e., Fraillon et al., 2014; Scherer et al., 2017).

The framework of the Basic ICT Competence Beliefs (BICB; Rubach & Lazarides, 2021), as conceptualized in previous studies, encompasses multiple dimensions of ICT competencies, each representing a distinct aspect of teachers' digital literacy and skills. The BICB framework leans on the theoretical framework of Situated Expectancy-Value Theory (SEVT; Eccles & Wigfield, 2020) and the Will, Skill, Tool Model of Technology Integration (Knezek & Christensen, 2016). Together, these two theories suggest that a teacher's decision to use ICT in their teaching is significantly influenced by their beliefs in their own ICT competence (will), their actual

ICT skills (skill), and the availability of technological tools within their educational environment (tool). The framework has the following dimensions: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety and Security, Problem Solving, and Analyzing and Reflecting (see Rubach & Lazarides, 2019;, 2021). Prior validations of the BICB scale have employed a range of models, from unidimensional constructs to more complex hierarchical and g-factor models. These models have been instrumental in fleshing out the multifaceted nature of ICT competencies and their interrelationships, offering insights into how these competencies manifest and interplay in diverse educational settings (Rubach & Lazarides, 2019, 2021). Our study builds upon this foundational work, aiming to extend its applicability and understanding in the context of preschool education in Asia, a region undergoing rapid digital transformation in its educational landscape.

In this study, we utilized Rubach and Lazarides' (2019) basic ICT competence beliefs (BICB) questionnaire to assess preschool teachers' ICT competence beliefs. This questionnaire assesses the multidimensionality and the hierarchical structure of teachers' basic ICT competence beliefs. Since the questionnaire has been newly developed, it has only been validated for student teachers from a university in Germany (Rubach & Lazarides, 2019) and primary, secondary, and special education teachers also in Germany (Rubach & Lazarides, 2021). As schools in Asia quickly adapt to e-learning and innovative pedagogies, it is also important to assess teachers' ICT competence beliefs to facilitate better technology-integrated teaching and learning strategies. Therefore, this study aims to validate the BICB (Rubach & Lazarides, 2019) for preschool teachers in Hong Kong and the Philippines.

4 Methods

4.1 Participants and procedures

Two hundred nine preschool teachers from The Philippines ($n=109$; $Mage=32.74$; $SD=8.13$) and Hong Kong ($n=100$; $Mage=34.19$; $SD=9.66$) complete the online survey. Previous simulation research has indicated that measurement invariance can be adequately tested between two groups with sample sizes as low as 100–200 per group (Eun & Yoon, 2011; Yoon & Millsap, 2007). Based on these studies, a target sample size of 100 participants per group was established for the current research, for a total planned sample of 200 across the two cultural contexts. The majority of the participants were female ($n=182$, 87.08%). 175 of the participants taught in a local school, while 34 of them taught in an international school. Invitation letters and consent forms were sent to various preschools in Hong Kong and the Philippines through email. Individual consent forms and a three-page online survey were sent to teachers who agreed to participate in the study. A HK$50 digital coffee voucher was given to participants after completing the questionnaire.

4.2 Instrument

Basic ICT competence beliefs. In-service teachers' basic ICT competence beliefs were assessed using a questionnaire that was previously validated in various samples of student teachers (Rubach & Lazarides, 2019) and in-service teachers covering primary, secondary, and special education teachers (Rubach & Lazarides, 2021). The survey consisted of 32 items (Rubach & Lazarides, 2021), where each item was assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire is composed of six dimensions specifically: (a) *Information and data literacy* (6 items [3 for *searching* and 3 for *storing*]), (b) *Communication and Collaboration* (6 items), (c) *Digital Content Creation* (4 items), (d) *Safety and Security* (4 items); (e) *Problem-solving* (7 items [4 for *operation* and 3 for *comprehension*]), and (f) *Analyzing and Reflecting* (5 items [3 for *analysis for distribution* and 2 for *analysis of business activities*]).

4.3 Data analysis

Preliminary analyses included item-level correlations. Confirmatory factor analysis (CFA) was implemented to test the BICB scale's factor using Rosseel's (2012) lavaan package. Given the extant factor structures of the BICB scale in the literature, we tested four models (see Fig. 1). First, we tested a unidimensional model with one latent factor explained by all 32 items of the BICB (Model 1). Second, we tested a nine-factor model (Searching, Storing, Communication and Collaboration, Digital content creation, Safety and security, Operation, Comprehension, Analysis of distribution, and Analysis of business activities; Model 2). Then, we tested a hierarchical model (see Rubach & Lazarides, 2019;, 2021) with three second-order factors (Information and data literacy, Problem-solving, and Analyzing and reflecting) and nine first-order factors from Model 2. More specifically, in this model (Model 3), "searching" and "storing" were loaded under the second-order latent variable "Information and data literacy", while "operation" and "comprehension" were loaded under "Problem-solving", and "Analysis of distribution" and "Analysis of business activities" were loaded under "analyzing and reflecting". Finally, we tested a g-factor model (see Rubach & Lazarides, 2021), which is configured similarly to the hierarchical model with a global third-order factor for all first- and second-order factors (Model 4). The global dimension pertains to the broader construct assessed by the BICB scale.

The selection of the four models for our CFA was informed by the extant factor structures of the BICB scale as documented in previous literature (Rubach & Lazarides, 2019, 2021). This literature-based approach was adopted to explore the multidimensionality and hierarchical nature of the BICB scale in a novel context—preschool teachers in Hong Kong and the Philippines. The rationale behind testing these models was twofold: firstly, to validate the established factor structures of the BICB scale in a new demographic, and secondly, to examine the scale's applicability and robustness across different cultural settings. Model 1, the unidimensional model, was tested to assess the general ICT competence as a singular factor. Model 2, the nine-factor model, was chosen to explore the distinct dimensions of ICT competencies identified in prior research. Model 3, the hierarchical model, allowed us to exam-

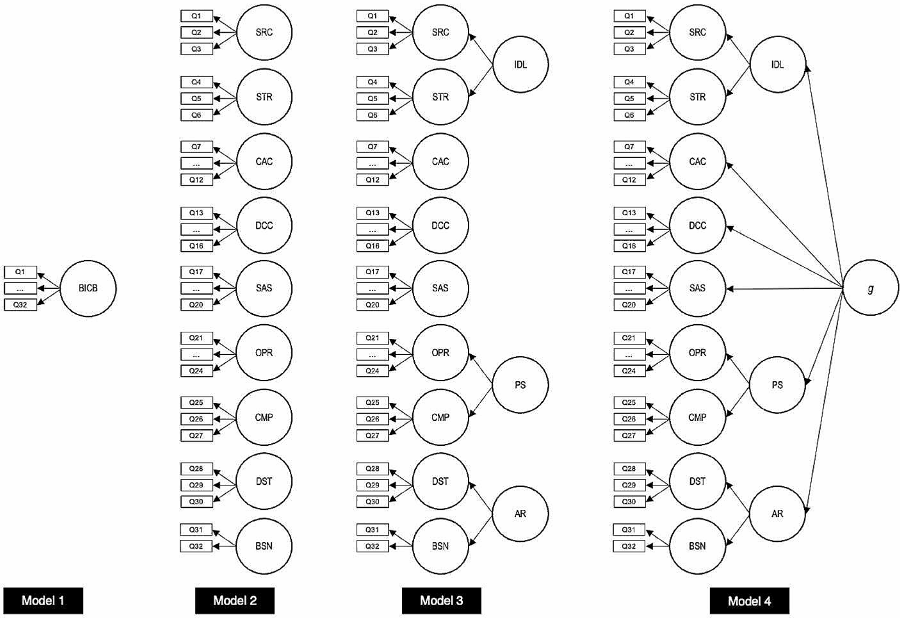

Fig. 1 Specified measurement models of preschool teachers' basic ICT competence beliefs (BICB). *Notes* Model 1 = unidimensional model, Model 2 = nine-factor model, Model 3 = higher-order model with 3 s-order factors and nine first-order factors, Model4 = g-factor model with 3 s-order factors and nine first-order factors. Src = Searching, Str = Storing, CAC = Communication and collaboration, DCC = Digital content creation, SAS = Safety and security, Opr = Operation, Cmp = Comprehension, Dst = Analysis of distribution, Bsn = Analysis of business activities, IDL = Information and digital literacy, PS = Problem solving, AR = Analyzing and reflecting. For clarity and parsimony, arrows for co-variances are not shown

ine the relationships between these dimensions, providing insights into how simpler competencies aggregate into more complex constructs. Lastly, Model 4, the g-factor model, was tested to explore the possibility of a global overarching factor that might encompass all the specific competencies. This stepwise approach in model testing not only aligns with the previous validations of the BICB scale but also adds depth to our understanding of the scale's factor structure across educational settings.

Considering the ordinal nature of the responses and to account for potential non-normality, all CFA models were run using the Weighted Least Squares with Mean and Variance (WLSMV) adjusted estimator. The superiority of WLSMV over both Weighted Least Squares and Maximum Likelihood estimation methods, particularly in small to moderate sample sizes and complex models (Flora & Curran, 2004). We used the Satorra-Bentler scaled test statistic to test the CFA models. Satorra-Bentler chi-square tests (SBχ2) were obtained, and the fit indices of the tested factor structures were compared. Several goodness-of-fit indices were evaluated: Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and standardised root mean square residual (SRMR). Models with CFI and TLI which were greater than 0.90 and RMSEA less than 0.08 were deemed to have a good fit for the data (Hu & Bentler, 1995), while an SRMR value less than 0.08 was also deemed as a good fit to the data (Hu & Bentler, 1999).

Multigroup Confirmatory Factor Analysis (MGCFA) was employed to examine measurement invariance across the two contexts: Hong Kong and the Philippines. This analysis was performed using the equal test MI method (Jiang et al., 2021). In assessing measurement invariance, we adhered to the guideline set by Chen (2007). The guidelines suggests that measurement invariance is indicated by a Comparative Fit Index change (ΔCFI) of 0.01 or less, and this should be further supported by a change in the Root Mean Square Error of Approximation (ΔRMSEA) of 0.15 or less, or a change in the Standardized Root Mean Square Residual (ΔSRMR) of 0.03 or less. The initial multigroup CFA model for each demographic group was established, with all factor loadings, uniqueness, and correlations set to be freely estimated. Following this, configural, metric, and scalar invariance tests were conducted by imposing constraints on the factor structure, factor loadings, and intercepts, respectively. Simulation studies have demonstrated that sample sizes of 100–200 per group provide sufficient power to test for measurement invariance using MGCFA (e.g., Eun & Yoon, 2011; Millsap & Everson, 1993; Yoon & Millsap, 2007). Therefore, the current sample sizes of 109 participants from the Philippines and 100 from Hong Kong ($N=209$) were deemed adequate to evaluate if the BICB scale functioned equivalently across cultures using MGCFA.

5 Results

All models yielded excellent fit indices (see Table 1). The unidimensional model (Model 1) yielded the following fit indices: $SB\chi^2(464)=643.46$, CFI=0.971, TLI=0.969, RMSEA=0.065, SRMR=0.096. The model with the nine-factor model (Model 2) had an $SB\chi^2(428)=517$, CFI=0.992, TLI=0.990, RMSEA=0.036, SRMR=0.055. Further, the hierarchical model (Model 3) showed $SB\chi^2(443)=535.22$, CFI=0.990, TLI=0.988, RMSEA=0.040, SRMR=0.060. Finally, the g-factor model (Model 4) yielded $SB\chi^2(452)=558.51$, CFI=0.985, TLI=0.984, RMSEA=0.047, SRMR=0.070.

In assessing the fit of our models, we employed a chi-squared difference test. The nine-factor model (Model 2) demonstrated the lowest χ^2 value ($\chi^2=247.74$). This model served as the reference model for the subsequent pairwise comparisons. The hierarchical model (Model 3) differed significantly from the nine first-order factors model. The difference in χ^2 values between these two models was significant ($\Delta\chi^2=28.278$, $\Delta df=15$, $p=0.019$). The g-factor (Model 4) also demonstrated a significant difference in fit when compared to the nine first-order factors model, with a $\Delta\chi^2=25.997$, $\Delta df=9$, $p=0.002$. The unidimensional model (Model 1) exhibited the most substantial difference from the nine first-order factors model. This difference was highly significant, with a $\Delta\chi^2=70.568$, $\Delta df=12$, and $p<0.001$. Based on these results, the nine-factor model (Model 2) appears to provide the superior fit to the data compared to the alternative models, as indicated by the lowest. The factor loadings of the nine-factor structure are shown in Fig. 2. Correlation analyses of the BICB factors showed positive pairwise correlation, with coefficients ranging from $r=0.42$ to 0.88

Table 1 Multigroup CFA results demonstrating the measurement invariance of the nine-factor model across contexts

Models	SBX2	df	TLI	CFI	RMSEA	SRMR	CFIdiff	RM-SEAdiff	SRMR-diff	In-vari-ant
One-factor model	643.46	464	0.969	0.971	0.065	0.096	---	---	---	---
Nine-factor model	517.00	428	0.990	0.992	0.036	0.055	---	---	---	---
Hierarchical model	535.22	443	0.988	0.990	0.040	0.060	---	---	---	---
g-factor model	558.51	452	0.984	0.985	0.047	0.070	---	---	---	---
Measurement invariance										
Nine-factor - CH	456.50	428	0.989	0.990	0.038	0.074	---	---	---	---
Nine-factor - EN	489.79	428	1.043	1.000	0.040	0.070	---	---	---	---
Nine-factor - Configural	933.48	856	0.987	0.989	0.039	0.072	---	---	---	---
Nine-factor - Metric	943.22	879	0.988	0.989	0.037	0.077	0.000	-0.002	0.005	In-vari-ant
Nine-factor - Scalar	975.21	902	0.987	0.988	0.039	0.078	-0.001	0.002	0.001	In-vari-ant
Nine-factor - Strict (Error)	1007.14	934	0.987	0.988	0.039	0.081	0.000	0.000	0.003	In-vari-ant

(see Table 2). The Cronbach's alpha for the nine first-order factors are all high and ranged from α=0.83 to 0.91 (see Table 2).

To examine the measurement invariance across Kindergarten teachers from the Philippines and Hong Kong, a series of nested models were analyzed (see Table 1). The configural invariance, which sets the foundation for subsequent invariance tests, showed a good model fit: SBχ^2 (856)=933.48, CFI=0.989, TLI=0.987, RMSEA=0.039, SRMR=0.072, indicating that the factor structure was invariant across groups. Following this, metric invariance (i.e., equal factor loadings across groups) was supported with ΔCFI=0.000, ΔRMSEA = -0.002, and ΔSRMR=0.005, yielding a model fit of SBχ^2 (879)=943.22, CFI=0.989, TLI=0.988, RMSEA=0.037, SRMR=0.077. Scalar invariance, which suggests equal intercepts or thresholds across groups, was also supported with changes in fit indices ΔCFI = -0.001, ΔRMSEA=0.002, and ΔSRMR=0.001, and the model fit was SBχ^2 (902)=975.21, CFI=0.988, TLI=0.987, RMSEA=0.039, SRMR=0.078. Lastly, strict invariance was achieved with a model fit of SBχ^2 (934)=1007.14, CFI=0.988, TLI=0.987, RMSEA=0.039, SRMR=0.081, and the changes in fit indices were ΔCFI=0.000, ΔRMSEA=0.000, and ΔSRMR=0.003, indicating that the measurement error variances were equal across the two groups.

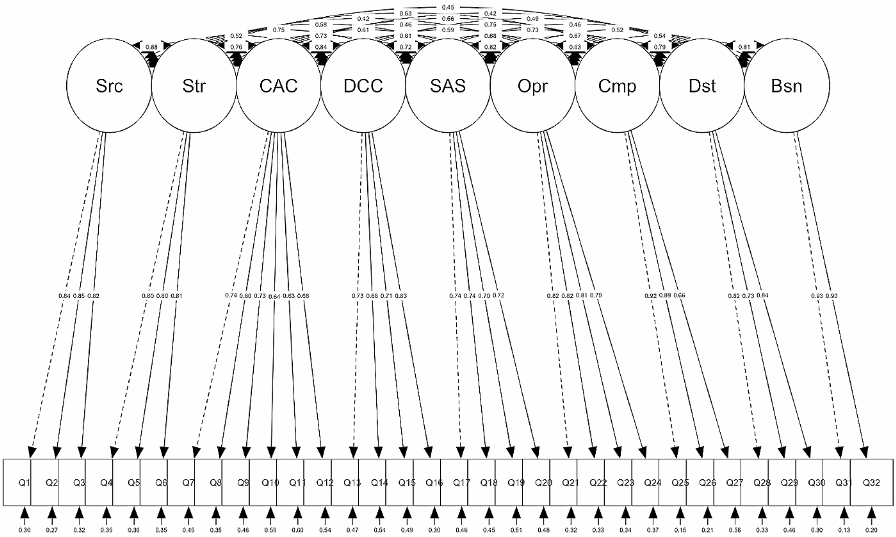

Fig. 2 The nine-factor structure of the BICB. Src=Searching, Str=Storing, CAC=Communication and collaboration, DCC=Digital content creation, SAS=Safety and security, Opr=Operation, Cmp=Comprehension, Dst=Analysis of distribution, Bsn=Analysis of business activities.

Table 2 Pairwise correlations among the factors in the nine-factor model

Factors	1	2	3	4	5	6	7	8	9
1. Searching	(0.88)	---	---	---	---	---	---	---	---
2. Storing	0.88	(0.85)	---	---	---	---	---	---	---
3. Communication and collaboration	0.72	0.76	(0.86)	---	---	---	---	---	---
4. Digital content creation	0.52	0.61	0.84	(0.85)	---	---	---	---	---
5. Safety and security	0.75	0.73	0.74	0.72	(0.83)	---	---	---	---
6. Operation	0.58	0.61	0.81	0.83	0.82	(0.89)	---	---	---
7. Comprehension	0.42	0.46	0.59	0.68	0.60	0.64	(0.86)	---	---
8. Distribution	0.53	0.56	0.75	0.73	0.67	0.79	0.80	(0.84)	---
9. Business	0.45	0.42	0.49	0.47	0.52	0.54	0.70	0.81	(0.91)

Note All correlations are latent covariances from the CFA and are significant at $p<0.001$. Cronbach's alpha of the factors are on the diagonal, within parentheses

IDL=Information and data literacy, CAC =, DCC =, SAS =, PS=Problem solving, AAR=Analyzing and reflecting, Src=Searching, Str=Storing, Opr=Operation, Cmp=Comprehension, Dst=Analysis of distribution, Bsn=Analysis of business activities

6 Discussion

This study aimed to validate the basic ICT competence beliefs questionnaire developed by Rubach and Lazarides (2019) among preschool teachers in Hong Kong and the Philippines. This research contributes to the literature by assessing its validity to preschool teachers in the Eastern context, such as Hong Kong and the Philippines. Since the questionnaire was newly developed, the previous study only utilized teachers from primary to secondary school teachers and special education teachers in Germany (Rubach & Lazarides, 2019). Therefore, this study can provide valuable input on its applicability to preschool teachers, specifically in the Asian context.

Overall, the CFA results support the factorial validity of the BICB among preschool teachers in an Asian context. Specifically, the 9-factor structure demonstrated superior model fit compared to plausible alternative models, with all factors also showing strong internal consistency reliability. While Rubach and Lazarides (2021) identified a different factor structure that better fit their data with primary/secondary teachers in Germany, the current study supported the original nine-factor model proposed in the BICB development. This discrepancy in factor structures across studies and populations highlights that the BICB may take on different factor structures depending on the sample and context.

In this study, the nine factors include: Information and Data Literacy, which refers to teachers' abilities to find, organize, store, and retrieve digital information and data; Communication and Collaboration, which encompasses skills for using digital tools to communicate and collaborate with others; Digital Content Creation, indicating teachers' abilities to design, edit, and present digital content; Safety and Security, representing awareness of risks and protective strategies regarding digital environments; Problem Solving, involving operating digital tools and applying technical knowledge to address issues; Analyzing and Reflecting, concerning skills for assessing impacts and activities in digital spaces; Searching, involving online search abilities; Storing and Organizing, relating to managing digital files and data; and Operation and Usage, concerning customizing tools to meet needs. All factors also showed strong internal consistency reliability. Defining each confirmed factor provides context for interpreting the outcomes of validating the BICB questionnaire structure with preschool teachers in the current study.

There are a few possibilities for why the nine factors were clearly distinguished for preschool teachers in the Asian context of Hong Kong and the Philippines, compared to the fewer merged factors found among primary and secondary teachers in Germany (Rubach & Lazarides, 2021). Early childhood education approaches tend to emphasize distinct skill areas compared to later grades (Hu & Yelland, 2019). For example, ECE places a strong focus on basic digital literacy, communication development, and personal safety awareness as foundational skills (Dong, 2018a, b; Ihmeideh & Al-Maadadi, 2018). This alignment between the curriculum priorities and validated factors may have led to clearer distinctions between the BICB areas for preschool educators. Cultural differences may also play a role, as technology integration in Asian ECE emphasizes familiar and practical applications more than theoretical technology knowledge (Kurent & Avsec, 2023; Yang & Hong, 2022). This could make factors involving discrete applications (e.g., content creation, problem-solving sub-skills) more distinct versus emphasis on underlying principles tying factors together. Furthermore, the distinct pedagogical approaches in Asian ECE settings, particularly those that are technology-enabled, might also contribute to these differences in factor distinction. Overall, contextual considerations around developmental appropriateness, curriculum, and culture could account for the nine validated factors standing out separately for Asian preschool teachers versus some consolidation of factors seen in primary/secondary educators in other contexts (Aditya et al., 2022; Barbara-Sanchez et al., 2022; Rubach & Lazarides, 2021).

Notably, measurement invariance testing revealed configural, metric, scalar, and strict invariance of the 9-factor model across the Hong Kong and the Philippines samples. This demonstrates that the BICB measures the same constructs, in the same way, across these cultural contexts. Measurement invariance is a prerequisite for making meaningful group comparisons (Putnick & Bornstein, 2016). Thus, these findings provide a rigorous psychometric foundation for future BICB studies examining how preschool teachers' ICT competence beliefs may vary cross-culturally.

A key contribution of this study was extending the validation of the BICB questionnaire to preschool teachers. While technology adoption is expanding rapidly in early childhood globally (OECD, 2015), most prior assessments of teachers' technology-related competence beliefs focused narrowly on primary through secondary grades (Herzig & Martin, 2018; Scherer et al., 2017). However, successful technology integration relies heavily on early educators feeling confident in using tools appropriately for young learners (Fraillon et al., 2020). Assessing preschool teachers' self-efficacy beliefs is therefore imperative to understanding integration challenges uniquely faced in early learning contexts. The BICB addresses this need by providing a domain-general instrument for pinpointing preschool teachers' strengths and development opportunities regarding technological pedagogical skills (Dong, 2018b). By validating the BICB for this under-researched population, the current study fills an important gap and lays the groundwork for more nuanced examinations of technology integration specific to early childhood educational settings and curricula and across contexts.

A key strength of this study was extending the validation of the BICB to preschool teachers specifically. Most prior tools measuring teachers' technology-related competence beliefs focused on primary through secondary school contexts (Herzig & Martin, 2018; Scherer et al., 2017). However, as ICT integration efforts expand to early childhood education globally, assessing preschool teachers' self-efficacy beliefs is critical. Teachers who feel more competent with technology are more likely to integrate it into their instruction (Rubach & Lazarides, 2021). The BICB provides a domain-general tool for identifying preschool teachers' strengths versus development needs in terms of technological knowledge and skills.

6.1 Limitations and directions for future research

Although our study provided significant correlations and confirmed good model fit of both the original hierarchical factorial structure and a better model with nine first-order factors structure, there are limitations that can be addressed. To validate the basic ICT competence beliefs questionnaire developed by Rubach and Lazarides (2019) among preschool teachers in Hong Kong and the Philippines, a cross-sectional study was implemented. Therefore, it is recommended for future studies to test its validity in a longitudinal design to establish longitudinal relationships and possible factorial structure changes over time. Second, we only recruited preschool teachers from Hong Kong and the Philippines, which limits its generalizability to these two contexts. Further investigation into other Eastern and Western contexts can be done to expand its validity. Third, as previous studies, including ours, adopted the classical test theory approach, it is also notable to test this using the latent theory approach. We also recommend exploring possible modifications to the BICB to make the instrument more context-sensitive, emphasizing the needs of the participants (i.e. situations more specific to pre-school setting). Future studies are also recommended to test the link of ICT competence beliefs to different educational technology outcomes, such as digital citizenship and media literacy, to offer deeper insights into its nomological networks.

7 Conclusion

This study contextualized technology integration in early childhood education amid Asia's digital shifts (Kurent & Avsec, 2023; Yang & Hong, 2022) by validating the Basic ICT Competence Beliefs (BICB) questionnaire among preschool teachers in Hong Kong and the Philippines. The results provide further valid evidence across cultural contexts (Rubach & Lazarides, 2021). The findings supported the original nine-factor structure of the scale (Rubach & Lazarides, 2019), and measurement invariance testing demonstrated the BICB functions equivalently across both contexts. By accurately measuring teachers' multidimensional ICT perceptions (Rubach & Lazarides, 2021), the BICB can be used to identify educator strengths and needs to inform targeted professional learning efforts (Fraillon et al., 2020; Herzig & Martin, 2018). This represents an important step for empowering teachers in technology-rich learning environments (Dong, 2018a; Scherer et al., 2015). Overall, this study establishes a sound internal psychometric validation of the BICB, supporting its future application and use across diverse contexts globally (Barbara-Sanchez et al., 2022; Rubach & Lazarides, 2021).

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Author contributions J. P. V. – Preparation and writing of the manuscript (Introduction, literature review, methods, and discussion). NBM: Wrote the data analysis section and analyzed the data. Dr. Mendoza also contributed in completing the discussion section and revision of the manuscript.

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Data availability Data are available from the authors upon request.

Declarations

Conflict of interest There is no conflict of interest in the present study.

Ethical approval This study attained an approved ethical application from the first author's university. Informed consent was also obtained from all participants.

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