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Psychometric Evaluation and Measurement Invariance of the Chinese Version MSLQ Academic Self-Efficacy Scale in Early Childhood Pre-Service Teachers

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Abstract

As academic self-efficacy is one of the most significant indicators of the quality of teacher education, the issue of low academic self-efficacy among early childhood pre-service teachers is a matter of concern. While the MSLQ Academic Self-Efficacy Scale (MSLQ-ASES) is the most commonly and widely reported instrument for measuring academic self-efficacy, there are no studies that evaluate the appropriateness of the MSLQ-ASES for early childhood pre-service teachers in China. This study aimed to provide a Chinese version of MSLQ-ASES (C-MSLQ-ASES) and to evaluate its psychological properties in the context of Chinese early childhood pre-service teachers. Two sub-samples (n1=220, n2=398) were chosen using a simple random sampling method from different areas of China. Construct validity, convergent validity, measurement invariance, criterion-related validity, internal consistency, and composite reliability analysis were performed individually to assess the psychometric properties of C-MSLQ-ASES. The results of EFA confirmed a single factor of C-MSLQ-ASES. The CFA results showed that both the 9-item and 7-item factor structure models demonstrated favorable fit indices. Meanwhile, the 9-item scale had slight advantages in measurement invariance across age, criterion-related validity, and reliability. Our findings offer substantial evidence supporting that the 9-item C-MSLQ-ASES is a reliable and scientific instrument for assessing the academic self-efficacy of Chinese early childhood pre-service teachers, which will benefit the work of teachers, educational administration, and future researchers.

Keywords: psychometric properties, measurement invariance, MSLQ Academic Self-Efficacy Scale, early childhood pre-service teachers

1. Introduction

According to Bandura (1997), self-efficacy is defined as individuals' beliefs in their ability to effectively plan and execute the necessary actions to perform competently in a specific domain (Goldoust et al., 2022). In the context of teacher education, academic self-efficacy can be seen as the sense of self-efficacy that pre-service teachers (PSTs) exhibit in the learning and academic domain, and has been viewed as one of the most significant indicators of the quality of teacher education (Pajares, 2006; Glackin & Hohenstein, 2018). It refers to PSTs' estimations and assessments of their capability to successfully do certain academic activities and attain particular academic objectives (Li & Bai, 2018; Özhan, 2021). PSTs' academic self-efficacy serves as a crucial indicator for assessing learning motivation and strategies, playing an important role in education and teaching. Research has confirmed that academic self-efficacy positively influences academic performance (Tong & Miao, 2019) and is positively correlated with learning engagement and grit (Ouweneel et al., 2011; Özhan, 2021). On the other hand, PSTs with higher academic self-efficacy tend to experience lower anxiety, learning burnout, and even dropout (Yang, 2019; Lin et al., 2020).

Additionally, according to previous research, the issue of insufficient student-teacher interaction in current teacher education classrooms in China has been acknowledged as a common reality, which leads to low academic self-efficacy among early childhood PSTs (Qin et al., 2021). Therefore, studying the academic self-efficacy of early childhood PSTs is crucial for improving the quality of early childhood teacher education in China and assessing early childhood PSTs' learning motivation and strategies.

1.1 Measurement of Academic Self-Efficacy

The Motivation Strategies for Learning Questionnaire (MSLQ) was developed by Pintrich et al. (1990) and was originally used to assess students' motivation and learning strategies. It is an important and widely used tool for measuring students' motivation and academic confidence in primary, secondary, and higher education in Western countries and globally (Duncan & McKeachie, 2005; Holland et al., 2018; Bonanomi et al., 2018). Notably, the MSLQ Academic Self-Efficacy Scale (MSLQ-ASES) with 9 items, one of the most crucial sub-scales of the MSLQ, plays an important role in assessing students' confidence in academic abilities (Pintrich et al., 1990). According to Honicke & Broadbent (2016) and Yokoyama (2024), the MSLQ-ASES has become the most commonly and widely reported measure of academic self-efficacy.

A review of existing research reveals that studies on the applicability of the Chinese version MSLQ-ASES (C-MSLQ-ASES) are still limited, with most focusing on the secondary education phase (Rao & Sachs, 1999; Lee et al., 2010; Xu, 2020; Wang et al., 2023; Gan et al., 2023). Only one study has concentrated on the university level (university students rather than PSTs) (Tong et al., 2020). In addition, existing research findings are inconsistent. Furthermore, there are no studies that evaluate the appropriateness of the MSLQ-ASES for early childhood PSTs in China.

1.2 The Present Study

Previous studies have shown that, as samples and populations differ, the psychometric properties of MSLQ-ASES could be affected to a certain extent (Pintrich et al., 2000; Holland et al., 2018). Additionally, Holland et al. (2018) suggested that translating the scale into different languages may also affect its reliability. Since the MSLQ-ASES was originally developed based on a sample of American secondary students, there is a possibility that the MSLQ-ASES's psychometric properties could encounter certain cultural challenges when applied to early childhood PSTs in the context of Confucian culture in China.

Therefore, the primary purpose of this study was to perform a double-back translation of the MSLQ-ASES and analyze its psychological properties. We aimed to compare the model fits of the existing two models, including the original 9-item version and another revised 7-item version of the scale. Through this, we tried to figure out which model was more ideal in the context of early childhood PSTs in China. Then, convergent validity, criterion-related validity, measurement invariance, and internal consistency, as well as composite reliability of the C-MSLQ-ASES, were investigated. Validating the applicability of C-MSLQ-ASES in the Confucian cultural context may help improve the theoretical framework, promote

cross-cultural understanding, and provide a scientifically utilized, trustworthy instrument. These insights will ultimately have practical applications: generating targeted educational interventions, improving training practices, and informing education policy.

2. Materials and Methods

2.1 Participants and Sampling

This study utilized a cross-sectional survey research methodology. The sample was intentionally divided into two parts (sub-sample 1 and sub-sample 2) to gain a better understanding of the scale's psychometric properties in different areas of China. The two sub-samples were chosen using a simple random sampling method from two universities in Hainan (i.e., sub-sample 1, n=220; 204 female, 16 male; age range: 17–21, Mage=18.65, SD=0.70) and Sichuan (i.e., sub-sample 2, n=398; 384 female, 14 male; age range: 18–24, Mage=20.27, SD=0.99) provinces, respectively. The participants of this study specifically focused on early childhood PSTs. The latest statistics show that 316 6616 (97.61%) of the 324 4204 kindergarten teachers in China are women (Ministry of Education of the People's Republic of China, 2024). Thus, the gender balance of our two sub-samples was representative of the kindergarten teachers in China. In factor analysis, it is generally recommended that the sample size should be more than ten times the number of items in the instrument (Singh et al., 2016). In addition, power analysis outcomes conducted with G*Power 3.1 indicated that the minimum sample size required was 150, assuming a moderate effect size (f^2=0.15), α=0.05, and power=0.80. Therefore, our total sample (n=618) and both sub-samples (n1=220, n2=398) exceeded these thresholds, ensuring adequate statistical power for the factor analyses. Sub-sample 1 completed measures of academic self-efficacy and learning burnout. Sub-sample 2 completed a measure of academic self-efficacy only. Among those, we chose sub-sample 1 to conduct exploratory factor analysis (EFA) and two-tailed Pearson correlation analysis to investigate the underlying structure of the C-MSLQ-ASES and the criterion-related validity of C-MSLQ-ASES, respectively. Furthermore, sub-sample 2 was selected for confirmatory factor analysis (CFA) and multi-group CFAs to assess the fit of two regularly employed models and the measurement invariance of C-MSLQ-ASES, respectively.

While the survey was conducted in two provinces, participants enrolled in the study originated from 29 provinces across China (Table 1), providing evidence of significant demographic breadth. In addition, the nationwide unification of curriculum standards, certification policies, and program evaluation standards in teacher education ensures that universities are highly consistent. Accordingly, although the sampling frame was regional, the results are still valuable for drawing insights into early childhood pre-service teachers in China as a whole.

Table 1. Sociodemographic descriptions of the sample (n=618)

Variables	N (%)	SD	Variables	N (%)	SD
Gender		0.22	Home Province (continue)		10.10
Male	30 (4.9)		Henan	17 (2.8)	
Female	588 (95.1)		Heilongjiang	1(0.2)	
Age		1.18	Hubei	3 (0.5)	
17	3 (0.5)		Hunan	14 (2.3)	
18	96 (15.5)		Jilin	1(0.2)	
19	175 (28.3)		Jiangsu	1(0.2)	
20	202 (32.7)		Jiangxi	7 (1.1)	
21	99 (16.0)		Liaoning	6 (1.0)	
22	35 (5.7)		Inner Mongolia	3 (0.5)	
23	6 (1.0)		Ningxia	4 (0.6)	
24	2 (0.3)		Qinghai	15 (2.4)	
Home Province		10.10	Shandong	3 (0.5)	
Hainan	131 (21.2)		Shanxi	2 (0.3)	
Anhui	6 (1.0)		Shaanxi	14 (2.3)	
Beijing	1(0.2)		Sichuan	264 (42.7)	
Fujian	5 (0.8)		Tibet	14 (2.3)	
Gansu	29 (4.7)		Xinjiang	11 (1.8)	
Guangdong	9 (1.5)		Yunnan	8 (1.3)	
Guangxi	16 (2.6)		Zhejiang	6 (1.0)	
Guizhou	14 (2.3)		Chongqing	11 (1.8)	
Hebei	2 (0.3)				

2.2 Procedure

All participants were informed about the purpose of this study before data collection. The questionnaires were distributed anonymously through the questionnaire star APP, and the personal information of the participants was kept confidential by the researchers. To ensure data quality, the questionnaire star APP prevented the submission of incomplete questionnaires, resulting in a dataset with no missing values. Regarding the response rate, in Hainan province, 250 participants were invited and 220 valid responses were received (response rate=88.0%). In the Sichuan province, 420 participants were invited and 398 valid responses were obtained (response rate=94.8%). A summary of response rates is presented in Table 2.

Table 2. Response rate of the two sub-samples

Sub-samples	Invited participants	Returned questionnaires	Valid questionnaires	Response rate
Sub-sample 1	250	220	220	88.0%
Sub-sample 2	420	398	398	94.8%

2.3 Instruments

2.3.1 The MSLQ Academic Self-Efficacy Scale (MSLQ-ASES)

To assess participants' academic self-efficacy, the present study employed the MSLQ-ASES designed by Pintrich et al. (1990). In the original MSLQ-ASES, 9 items fall within the same dimension. Additionally, we utilized a 7-point Likert scale to ensure a higher reliability (Holland et al., 2018). This study adopted a double-back translation method to translate the original MSLQ-ASES into Chinese, which was renamed C-MSLQ-ASES. Two translators proficient in English and Chinese, and a psychology expert, were involved. In this study, the α value for MSLQ-ASES was 0.93.

2.3.2 Maslach Burnout Inventory-Student Survey (MBI-SS)

To test learning burnout, we employed the MBI-SS adapted for university students, as modified by Schaufeli et al. (2002). The questionnaire contains three sub-dimensions, namely exhaustion (EX, 5 items), cynicism (CY, 4 items), and professional efficacy (PE, 6 items). We used a 7-point Likert scale and utilized a double-back translation method for cross-cultural adaptation. The Alpha for MBI-SS was 0.88 in the present study.

2.4 Data Analysis

All data were analyzed using SPSS version 29 and Amos version 24. In the preliminary analysis, we reported the mean, standard deviation (SD), skewness, and kurtosis. Skewness and kurtosis values falling within the range of -1.00 to +1.00 indicated a highly normal distribution, while values from -2.00 to +2.00 were also considered to be relatively good (George & Mallery, 2003).

We performed EFA with sub-sample 1 using the principal component analysis extraction technique and rotation. The KMO and Bartlett tests were used to test whether the scale was suitable for factor analysis. For the factor loadings in EFA, a value of 0.4 or above was considered appropriate (Tabachnick, 2013).

After EFA, with sub-sample 2, we employed CFA to further examine the factorial structure model of both the 9-item and 7-item C-MSLQ-ASES, as well as its convergent validity. Model fit indices were determined by the following criteria: $\chi^2/df<5$ (Marsh & Hocevar, 1985), IFI>0.90 (Bollen, 1989), RMSEA<0.08 (Brown, 2015), SRMR<0.05 (Diamantopoulos & Siguaw, 2000), CFI>0.95, TLI>0.94, GFI>0.95 (Weston et al., 2008). Additionally, a smaller AIC value indicates a better model fit (Duffin et al., 2012). In terms of convergent validity, we examined the AVE (AVE>0.50) value and CR (CR>0.60) value of the C-MSLQ-ASES (Bagozzi & Yi, 1988).

Subsequently, we conducted multi-group CFAs to further evaluate the equivalence of the two models across different ages and school years. We divided the sub-sample 2 into two age groups (i.e., age group 1, below or equal to 20 years old, n=258; age group 2, above or equal to 21 years, n=140) and school year groups (i.e., school year group 1, freshmen and sophomores, n=236; school year group 2, junior and senior, n=162) respectively. Firstly, we analyzed χ^2, df, χ^2/df, TLI, CFI, and RMSEA, and then we observed the Δdf, ΔTLI, ΔCFI, and

ΔRMSEA. Given the sensitivity of χ^2 to sample size, focusing on ΔRMSEA and ΔCFI is a more prudent choice (Cheung & Rensvold, 2002; Chen, 2007). In addition, when the value $\Delta\chi^2$ is not significant, ΔTLI≤0.02 and ΔCFI≤0.01 can also confirm model identity (Wang & Wang, 2012). Therefore, the criteria we employed are as follows: ΔRMSEA≤0.015, ΔCFI≤0.01, ΔTLI≤0.02 (Cheung & Rensvold, 2002; Chen, 2007; Wang & Wang, 2012).

Afterward, we analyzed the criterion-related validity of C-MSLQ-ASES through a two-tailed Pearson correlation analysis. According to Cohen (1988), the correlation strength (r) is categorized as very high if r>0.70; large if 0.30<r<0.70; medium if 0.10<r<0.30; and low if r<0.10. These criteria helped us assess the strength and significance of the correlations when assessing the validity of the scale.

Lastly, Cronbach's Alpha and composite reliability values (ρ) were utilized to assess the scale's reliability in all participants (n=618) and sub-sample 2, respectively. A Cronbach's Alpha value greater than 0.70 was considered to be ideal (Karagöz, 2018), and a value surpassing 0.90 was extremely satisfactory (Terwee et al., 2007). Regarding ρ, an acceptable range is between 0.60 and 0.70, a satisfactory range is between 0.70 and 0.90, and a perfect range is greater than 0.90 (Nunnally & Bernstein, 1994).

3. Results

3.1 Preliminary Analysis

Table 3 presents the results of the preliminary analysis of the data collected from 618 participants, including mean, SD, skewness, and kurtosis. In terms of the mean and SD, the 9 items specifically ranged from 4.28 to 5.32 and 1.01 to 1.26, respectively. This indicated that there were certain differences in the levels of participants on certain items. In general, participants demonstrated moderate levels of academic self-efficacy. In addition, Skewness and Kurtosis specifically ranged from -0.23 to 0.26 and -0.34 to 1.16, respectively. Preliminary analysis results of the data showed that all 9 items of C-MSLQ-ASES meet the basic requirements of normal distribution.

Table 3. Descriptive statistics for 9-item C-MSLQ-ASES

Items	Sample (n=618)			
	Mean	Standard Deviation	Skewness	Kurtosis
ASE 1	5.18	1.26	-0.23	-0.25
ASE 2	4.89	1.11	0.03	0.25
ASE 3	5.32	1.18	-0.21	-0.29
ASE 4	4.80	1.26	-0.02	-0.09
ASE 5	4.82	1.14	0.06	0.09
ASE 6	4.82	1.09	0.13	0.13
ASE 7	4.28	1.10	-0.02	1.16
ASE 8	4.39	1.01	0.19	0.85
ASE 9	4.95	1.09	0.26	-0.34

Abbreviation. ASE, academic self-efficacy.

3.2 Construct Validity

3.2.1 Exploratory Factor Analysis

EFA was conducted with a sub-sample of 220 early childhood PSTs (sub-sample 1). Table 4 displayed the factor loadings of the 9 items of C-MSLQ-ASES, with values varying between 0.67 and 0.89. All items fell on the same dimension, indicating that one principal component was extracted. Furthermore, the first principal component is the most significant contributor to the variation in the dataset, accounting for 63.42% of the total variance. In addition, the analysis also revealed a KMO value of 0.91, and Bartlett's test yielded a result of χ^2=1 409.81, df=36, p<0.001. The above results were ideal, suggesting that the data were suitable for factor analysis and provided a reliable basis for subsequent analysis.

Table 4. EFA for the 9-item C-MSLQ-ASES (n=220)

Items		Factor loading	Factor
1	ASE 1	0.77	
2	ASE 2	0.69	
3	ASE 3	0.67	
4	ASE 4	0.81	
5	ASE 5	0.88	ASE
6	ASE 6	0.89	
7	ASE 7	0.86	
8	ASE 8	0.87	
9	ASE 9	0.71	

Abbreviation. ASE, academic self-efficacy.

3.2.2 Confirmatory Factor Analysis

To further investigate the factor structure of C-MSLQ-ASES, considering the one-factor model found by EFA and existing literature on MSLQ-ASES's factor structure, we examined the factorial structures of C-MSLQ-ASES with another sub-sample of 398 early childhood PSTs (sub-sample 2) through CFA. The specific factor structures of the two models investigated in this study are "Model 1" (Pintrich et al., 1990): one factor (9-item, i.e., items 1 - 9), and "Model 2" (Lee et al., 2010): one factor (7-item, i.e., items 1, 2, 4, 5, 6, 7, 9). Since the initial fitting results of Model 1 and Model 2 were not satisfactory, we revised the two models according to MIs and then renamed them Modified Model 1 and Modified Model 2. Table 5 presents a comparison of the fit indexes of CFA on these 4 models.

The results revealed that both Modified Model 1 (χ^2/df=3.44) and Modified Model 2 (χ^2/df=3.45) demonstrated a relatively high and acceptable fit. Likewise, evidence was provided by other good indicators for both models: Modified Model 1 (χ^2=79.19, df=23, GFI=0.96, AGFI=0.92, RMSEA=0.078, SRMR=0.035, CFI=0.98, TLI=0.96, IFI=0.98), Modified Model 2 (χ^2=41.39, df=12, GFI=0.97, AGFI=0.93, RMSEA=0.079, SRMR=0.026, CFI=0.98, TLI=0.97, IFI=0.98). However, Modified Model 2 demonstrated a lower AIC

value of 73.39 compared to Modified Model 1, indicating a better model fit. Even if slight differences were observed, both models demonstrated excellent performance, affirming their applicability for research.

Table 5. Fit indices of the CFA of different models (n=398)

	No. of factors	Item No.	χ^2	df	χ^2/df	GFI	AGFI	RMSEA	SRMR	CFI	TLI	IFI	AIC
Model 1	1	9	354.35	27	13.12	0.83	0.71	0.175	0.066	0.87	0.82	0.87	390.35
Model 2	1	7	74.51	14	5.32	0.95	0.90	0.104	0.037	0.96	0.95	0.96	102.51
Modified Model 1	1	9	79.19	23	3.44	0.96	0.92	0.078	0.035	0.98	0.96	0.98	123.19
Modified Model 2	1	7	41.39	12	3.45	0.97	0.93	0.079	0.026	0.98	0.97	0.98	73.39

Note. Model 1 (9 items) was established by Pintrich et al. (1990); Model 2 (7 items) was recommended by Lee et al. (2010).

Abbreviations. GFI, goodness of fit; AGFI, adjusted GFI; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual; CFI, comparative fit index; TLI, Tucker-Lewis index; IFI, incremental fit index; AIC, Akaike information criterion.

3.3 Convergent Validity

As for Modified Model 1, the AVE and CR values were 0.57 and 0.92, respectively. The AVE and CR values of the 7-item Modified Model 2 were 0.58 and 0.91. The above results indicated that both modified models had appropriate convergent validity.

3.4 Measurement Invariance

To thoroughly evaluate the equivalence of the two models (i.e., Modified Model 1 and Modified Model 2) across different ages and school years, Multi-group CFAs were conducted with sub-sample 2. Specifically, we assessed four levels of measurement invariance, which include configural, metric, scalar, and residual invariance (Cheung & Rensvold, 2002). As shown in Table 6, we observed the ΔRMSEA, ΔCFI, and ΔTLI results of the two models (Chen, 2007; Cheung & Rensvold, 2002; Wang & Wang, 2012). The changes in the fit indices of Modified Model 1 across age and school year all met the criteria (ΔRMSEA<0.015, ΔCFI<0.01, ΔTLI<0.02). In Modified Model 2, the changes in the fit indices across the school year also met the criteria, whereas the change in CFI (ΔCFI=0.2) for age-related residual invariance surpassed the standard threshold of 0.01. These results suggested that Modified Model 2, the 7-item C-MSLQ-ASES, did not show age invariance. Therefore, we consider Modified Model 1, the 9-item C-MSLQ-ASES, to be a preferable choice in research.

Table 6. Measurement invariance across age and school year

Model & Invariance	χ^2	df	χ^2/df	TLI	CFI	RMSEA	Δdf	ΔTLI	ΔCFI	ΔRMSEA
Modified Model 1										
Age										
Configural invariance	153.17	46	3.33	0.93	0.96	0.08	-	-	-	-
Metric invariance	158.70	54	2.94	0.95	0.96	0.07	8	0.01	0.00	0.01
Scalar invariance	166.64	63	2.65	0.95	0.96	0.06	9	0.01	0.00	0.01
Residual invariance	203.77	77	2.65	0.95	0.95	0.06	14	0.00	0.01	0.00
School year										
Configural invariance	128.23	46	2.79	0.95	0.97	0.07	-	-	-	-
Metric invariance	136.74	54	2.53	0.96	0.97	0.06	8	0.01	0.00	0.01
Scalar invariance	145.79	63	2.31	0.96	0.97	0.06	9	0.01	0.00	0.00
Residual invariance	191.51	77	2.49	0.96	0.96	0.06	14	0.01	0.01	0.01
Modified Model 2										
Age										
Configural invariance	68.38	24	2.85	0.96	0.97	0.07	-	-	-	-
Metric invariance	73.17	30	2.44	0.96	0.97	0.06	6	0.01	0.00	0.01
Scalar invariance	77.60	37	2.10	0.97	0.98	0.05	7	0.01	0.00	0.01
Residual invariance	114.21	47	2.43	0.96	0.96	0.06	10	0.01	0.02	0.01
School year										
Configural invariance	78.14	24	3.26	0.94	0.97	0.08	-	-	-	-
Metric invariance	84.63	30	2.82	0.96	0.97	0.07	6	0.01	0.00	0.01
Scalar invariance	93.58	37	2.53	0.96	0.97	0.06	7	0.01	0.00	0.01
Residual invariance	120.70	47	2.57	0.96	0.96	0.06	10	0.00	0.01	0.00

Note. To calculate ΔTLI, we first obtain the raw results (to three decimal places) through model comparison in AMOS and then round the values to two decimal places. Likewise, for ΔCFI and ΔRMSEA, we calculate based on the original results and then round to two decimal places.

Abbreviations. TLI, Tucker-Lewis index; CFI, comparative fit index; RMSEA, root mean square error of approximation.

3.5 Criterion-related Validity

Table 7. Correlation between the C-MSLQ-ASES and MBI-SS (n=220)

Scale	EX	CY	Reduced PE	LB (MBI-SS total scale)
C-MSLQ-ASES (9-item)	-0.329**	-0.371**	-0.720**	-0.588**
C-MSLQ-ASES (7-item)	-0.329**	-0.370**	-0.707**	-0.583**

Note. ** $p \leq 0.01$.

Abbreviations. EX, exhaustion; CY, cynicism; PE, professional efficacy; LB, learning burnout.

As shown in Table 7, both the 9-item and the 7-item C-MSLQ-ASES scale exhibited significant negative correlations with the MBI-SS in all measurement dimensions ($p<0.01$). In particular, the correlation coefficients for the 9-item C-MSLQ-ASES between the EX, CY, reduced PE, and LB were -0.329 ($p<0.01$), -0.371 ($p<0.01$), -0.720 ($p<0.01$), and -0.588 ($p<0.01$), respectively (Cohen, 1988). The 7-item C-MSLQ-ASES correlated slightly less well with the CY, reduced PE, and MBI-SS total scale than the 9-item scale.

3.6 Reliability

In the reliability statistics, the Cronbach's Alpha value of the 9-item C-MSLQ-ASES (n=618) was 0.93. For sub-sample 1 (n=220) and sub-sample 2 (n=398), the reliability was 0.93 and 0.93, respectively. According to Table 8, the correlation between most items and the total score was relatively high. After deleting an item, the overall Cronbach's Alpha coefficient remained within the range of 0.91 to 0.92. In addition, the composite reliability value ρ was 0.91. The above results were satisfactory, indicating a high degree of internal consistency and composite reliability of the 9-item C-MSLQ-ASES. Notably, the Cronbach's Alpha of the 7-item C-MSLQ-ASES (n=618) after deleting two items was 0.91, and the ρ was 0.86, which were both lower than the original version of the 9-item scale.

Table 8. Item-total correlation and Cronbach's Alpha analysis for the 9-item C-MSLQ-ASES (n=618)

Item		Corrected item-total correlation	Cronbach's Alpha if item deleted
1	ASE 1	0.700	0.919
2	ASE 2	0.689	0.919
3	ASE 3	0.667	0.921
4	ASE 4	0.700	0.919
5	ASE 5	0.818	0.911
6	ASE 6	0.815	0.912
7	ASE 7	0.722	0.917
8	ASE 8	0.767	0.915
9	ASE 9	0.715	0.918

Abbreviation. ASE, academic self-efficacy.

4. Discussion

This study aimed to psychometrically evaluate the validity, measurement invariance, and reliability of the MSLQ-ASES in the context of Chinese early childhood PSTs. Our research filled a gap in the literature by providing, for the first time, evidence of the psychometric properties of the scale among professional groups of early childhood PSTs in Chinese Confucian culture. Additionally, this study enhanced the cross-cultural applicability of the scale and deepened the understanding of academic self-efficacy and learning burnout among Chinese early childhood PSTs.

This study successfully provided a Chinese version of MSLQ-ASES through the double-back translation method. In terms of the EFA results, we confirmed the single-factor structure of the C-MSLQ-ASES in the domain of early childhood education in China. This result was consistent with the original scale by Pintrich et al. (1990) and the findings from Rao & Sachs (1999) among Hong Kong samples. This finding illustrated the robustness of the single-factor C-MSLQ-ASES in measuring academic self-efficacy in both Hong Kong and Mainland China. It also provided more support for further exploration and application of the scale.

Regarding the CFA results, both the 9-item and 7-item C-MSLQ-ASES demonstrated strong model fit after modifications. Specifically, the 7-item C-MSLQ-ASES exhibited a slight advantage with a lower AIC value of 73.39 compared to 123.19 for the 9-item version. This indicated that the 7-item C-MSLQ-ASES has a slight advantage in terms of simplicity and efficiency. This discovery was consistent with Lee et al.'s (2010) findings concerning the 7-item scale in a sample of Hong Kong junior secondary students, confirming the stability of the single-factor structure of C-MSLQ-ASES in the Chinese context. In addition, both the 9-item and 7-item C-MSLQ-ASES showed strong convergent validity.

The results of multi-group CFAs offered further insights into model selection. Previous studies have not addressed the measurement invariance of the MSLQ-ASES across age and school year. Our findings indicate that the 7-item C-MSLQ-ASES does not exhibit measurement invariance across age. Thus, we consider the 9-item C-MSLQ-ASES to be a preferable choice due to its good measurement invariance across both age and school year. Another significant implication of our findings is that academic self-efficacy among early childhood PSTs may vary with age and school year. As crucial to psychological and developmental research, measurement invariance is a prerequisite for comparing means across various groups (Putnick & Bornstein, 2016). This provides ideas for further research on the academic self-efficacy of early childhood PSTs at different ages and school years, as well as strategies to improve it.

We also discovered that Chinese early childhood PSTs' academic self-efficacy was negatively associated with learning burnout. The results of this post-pandemic study are consistent with previous studies of early childhood PSTs in China (Yang, 2017). This negative connection emphasizes the significance of increasing academic self-efficacy in early childhood PSTs in order to reduce learning burnout. By February 2024, the unemployment rate for the urban labor force aged 16-24 (excluding students) remained high, at 15.3% (National Bureau of

Statistics, 2024). In the context of returning to offline classes after the epidemic and increasing employment pressure, our findings provide post-epidemic data to supplement the existing literature.

Concerning reliability, we discovered that the Cronbach's Alpha value of the 9-item scale (α=0.93) exceeded that of the 7-item questionnaire (α=0.91). This value surpassed those reported in previous studies among high school students in Turkey (α=0.75) (Erturan Ilker et al., 2014), Hong Kong (α=0.77) (Rao & Sachs, 1999), and Italy (α=0.89) (Bonanomi et al., 2018). Moreover, removing any single item reduced the internal consistency of the scale. Deleting two items (i.e., items 3 and 8) resulted in a reliability coefficient of 0.91, indicating that the deletion of items needs to be treated with caution. Additionally, the 9-item C-MSLQ-ASES also had a higher composite reliability coefficient (ρ=0.91) than the 7-item scale (ρ=0.86). All the above findings demonstrated that the 9-item C-MSLQ-ASES exhibited excellent reliability among Chinese early childhood PSTs. We also attempted to avoid over-interpretation and over-idealized estimation of the research results. Therefore, we lean towards the conservative and cautious choice, that is, choosing the 9-item C-MSLQ-ASES (Modified Model 1).

5. Limitations and Future Directions

This study has the following limitations. Firstly, the participants in this study were early childhood PSTs in Hainan and Sichuan provinces, China. Due to the limitations of sample selection, the generalizability of research results may be compromised. Secondly, this study is characterized as a cross-sectional study. This means that the findings may only indicate the level of academic self-efficacy at a specific point in time, but cannot reveal how it evolves.

Hence, future research may have the following directions. First, a broader coverage and different majors of samples should be selected to explore the applicability of the C-MSLQ-ASES to different groups of PSTs. Besides, to gain a more comprehensive understanding of the development of academic self-efficacy, it may be better for future researchers to adopt long-term follow-up or experimental research designs.

6. Conclusion and Contributions

In conclusion, this study fills a gap in the literature on the applicability of the MSLQ-ASES as an instrument for assessing academic self-efficacy among Chinese early childhood PSTs. We proposed a Chinese version of MSLQ-ASES, which was C-MSLQ-ASES, and verified its psychometric properties among Chinese early childhood PSTs. The research findings will benefit the work of teachers, educational administration, and future researchers.

More precisely, the significance of this study was threefold. First, it verified the applicability of the MSLQ-ASES in the Chinese cultural and early childhood PSTs context, potentially contributing to understanding and improving the relevant theories cross-culturally. Secondly, it may help to provide users and researchers with a more scientific instrument. In that case, we may gain a more comprehensive insight into the academic self-efficacy and learning burnout of Chinese early childhood PSTs. Ultimately, the findings will contribute to the development of targeted educational interventions to enhance the training and teaching

practices, PSTs' support programs, and the development of educational policies. It can be seen that the practical applications of the C-MSLQ-ASES extend beyond the scope of research and bring benefits to teachers, education administrators, and policymakers working to educate PSTs in early childhood education in China.

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