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DEVELOPMENT OF MEASUREMENT INSTRUMENTS FOR TEACHERS' LIFELONG LEARNING MINDSET, LEARNING HABITS AND SELF-DIRECTED LEARNING

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Abstract

Lifelong learning is a crucial process that contributes to the continuous professional advancement opportunities for teachers. To promote teachers as lifelong learners, it is essential to leverage comprehensive insights into key mobilizing factors for lifelong learning, including a Lifelong Learning Mindset, Learning Habits, and Self-Directed Learning. This research aims to 1) develop measurement instruments for teachers' Lifelong Learning Mindset, Learning Habits, and Self-Directed Learning, and to 2) examine the quality of the measurement instruments, including the establishment of norms for all three variables. The research sample consisted of 943 elementary school teachers, selected using stratified random sampling. The measurement instrument consisted of a questionnaire containing 35 items each utilizing a 5-point rating scale. The research findings show that item content validity ratio (CVR) values for each of the instrument subscales ranged between .71 and 1.00, while the content validity index (S-CVI) value for the entire scale was .97. The internal consistency reliability values for the individual variable subscales ranged from .925 to .963, while the construct validity using Confirmatory Factor Analysis (CFA) as measured by the Mplus program showed that the measurement model fit the empirical data at the .05 significance level. This study also established percentile norms for the developed instruments.

Keywords Lifelong Learning, Lifelong Learning Mindset, Learning Habits, Self-Directed Learning, Measurement Instruments

INTRODUCTION

Lifelong learning is a universally acknowledged principle that underscores a continuous nature of learning throughout an individual's lifespan, carrying implications that extend far beyond formal education. Recognized for its capacity to facilitate personal growth and support ongoing professional development, particularly among educators (OECD, 2019), it is imperative for educators to actively embrace this concept, recognizing the integral role of continuous learning in career advancement (Alzahrani, Almalki & Almossa, 2022; UNESCO Institute for Lifelong Learning: UIL, 2016). Recent scholarly discourse has witnessed a shift towards examining the process of cultivating lifelong learning, with a particular focus on intrinsic motivational factors within individuals. This evolving discourse aims to nurture aspects of

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lifelong learning beyond the mere acquisition of competencies, emphasizing the significance of variables such as learning mindset, motivation, attitudes, and habits in sustaining lifelong learning trajectories (Blaschke, 2021; Drewery, Sproule & Pretti, 2020; Ehlers & Kellermann, 2019; Eppler-Hattab, 2022). These variables are regarded as pivotal in mobilizing individuals towards embracing lifelong learning efforts. This study endeavors to explore the centrality and relevance of mediating variables in promoting lifelong learning. It posits that lifelong learning is fostered through these mediating factors. These factors, while not directly contributing to the development of lifelong learning competencies, indirectly facilitate their cultivation (Annuar et al., 2022). Specifically, this article aims to devise instruments for capturing the essence of variables conducive to lifelong learning, namely Lifelong Learning Mindset, Learning Habits, and Self-Directed Learning. These internal factors are deemed essential for individuals to cultivate a lifelong learning mindset, being aligned with the intrinsic notion of self-directed learning inherent in the concept of lifelong learning.

REVIEW OF KEY CONCEPTS

Promoting lifelong learning can be divided into two main categories: personal factors and environmental factors (Acar & Ucus, 2017). While research mostly focuses on personal factors, which are the qualities individuals work on within themselves, it is important to see that these qualities have many sides to them. Among these personal factors are mindset, attitude, habits, motivation, skills, and self-directed learning (Parmelee et al., 2020; Toh et al., 2022). Additionally, there are traits which should be considered, such as being interested in learning, taking action to overcome challenges (Ricotta et al., 2022; Sproule, Drewery & Pretti, 2019), being open to new experiences, and being willing to adapt to changes in technology at work (Kiliç & Kiliç, 2022). Even though these factors have different names, they often share similar qualities. This leads researchers to group them into three main factors that drive lifelong learning, known as key mobilizing factors: lifelong learning mindset, learning habits, and self-directed learning.

1. Lifelong Learning Mindset (LLM): Rooted in Dweck's (2006) seminal work on the "growth mindset," this concept distinguishes individuals who believe in positive development, from those entrenched in a fixed mindset. Individuals with a growth mindset demonstrate receptivity to self-development, a propensity to embrace challenges, and a foundation conducive to personal and professional growth and accomplishment (Drewery, Pretti, & Church, 2020; Sloychuk et al., 2020; Sproule, Drewery & Pretti, 2019; Valtierra & Siegel, 2022).

2. Learning Habits (LH): Drawing inspiration from Clear's (2018) framework of Atomic Habits, learning habits seek to mold individuals' identities towards goal attainment. This entails setting attainable objectives, cultivating resilience, nurturing determination, and perseverance, and incrementally shaping behaviors until desired goals are achieved.

3. Self-Directed Learning (SDL): Pioneered by Knowles (1975) in the context of adult education, this concept empowers learners with autonomy to delineate their learning trajectory. It encompasses five progressive stages: creating a learning climate for oneself, diagnosing learning needs, setting learning goals, planning and managing learning, and evaluating and reflecting on the learning experience.

Recognizing the crucial role of these three variables, there is a pressing need to develop strong measurement tools that can effectively capture essential insights for nurturing individuals as lifelong learners. Existing research primarily focuses on lifelong learning skills (Drewery, Pretti, & Church, 2020; Sproule, Drewery & Pretti, 2019), yet there is a lack of clear tools to measure SDL and LH. While some measurement structures have been proposed for assessing LLM, precise measurement tools are still lacking. This knowledge gap underscores

the necessity for further research to explore how to evaluate LLM, LH, and SDL, particularly in teachers' professional development.

CONCEPTUAL FRAMEWORK

From the study of related documents, the structure of the measurement model was determined with 3 variables: 1) LLM, which consists of 3 sub-components: M1: Perception of the importance of self-learning development, M2: A positive attitude towards lifelong learning, and M3: Determination and commitment to learning; 2) LH, which consists of 3 sub-components: H1: Goal setting for cultivating positive learning habits, H2: Engaging in self-practice to attain learning objectives, and H3: Maintaining continuous learning until it becomes a habit; and 3) SDL, which consists of 5 sub-components: S1: Creating a learning climate for oneself, S2: Diagnosing learning needs, S3: Setting learning goals, S4: Planning and managing learning, and S5: Evaluating and reflecting on the learning experience (Diagram 1).

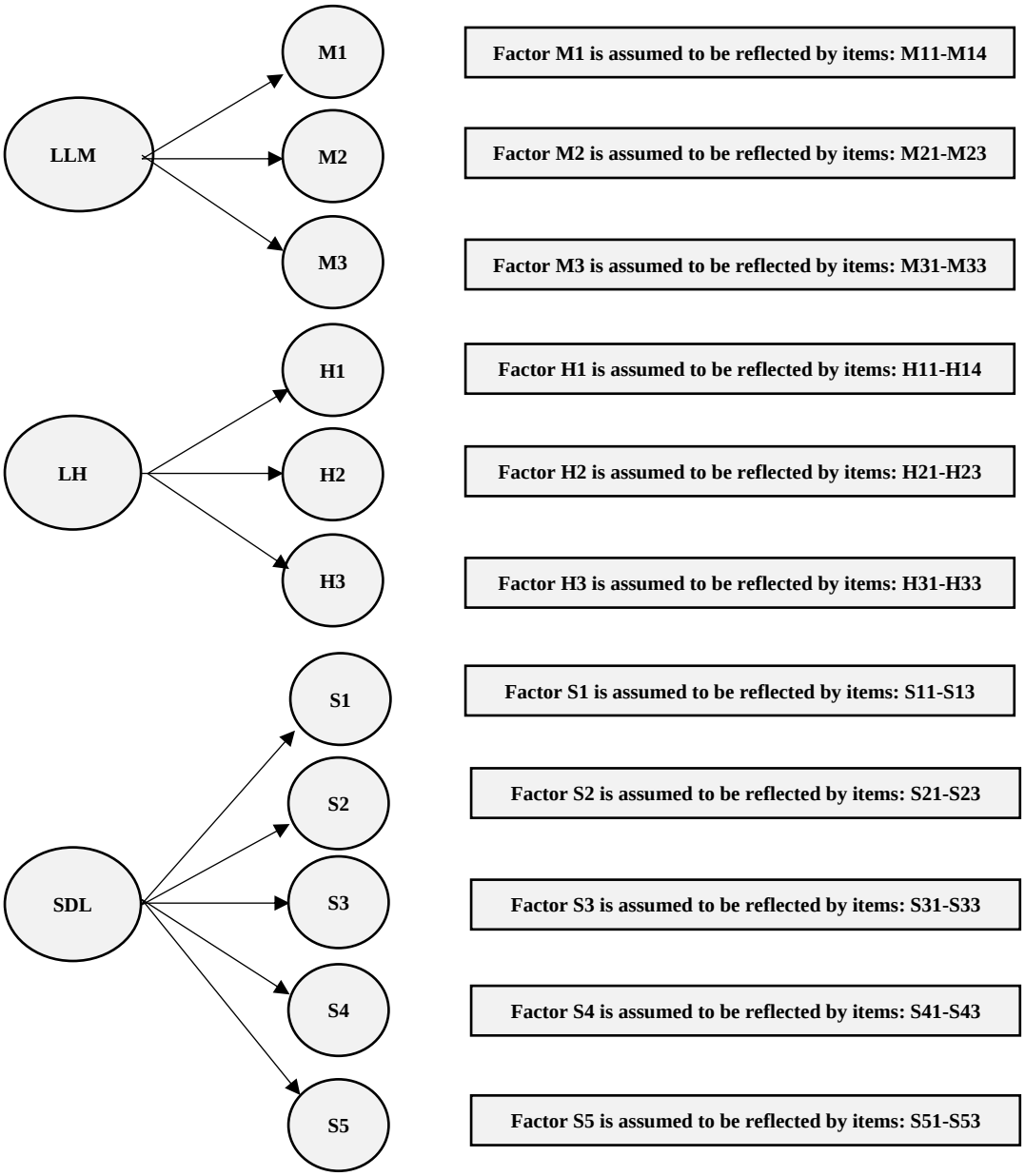


Diagram 1: Conceptual Framework of the Measurement Model

Purposes

This research aims to develop instruments for measuring the LLM, LH, and SDL of teachers, and to assess the quality of the developed measurement instruments. Additionally, the study aims to establish norms for all three variables.

METHODS

Sample Size

This study focuses on elementary school teachers as a sample, as it is part of research studying lifelong learning for this specific group. However, the instrument being developed is intended for use by all teachers as it is designed to be independent of specific teaching contexts.

The determination of the sample size for the teacher population was accomplished through Cohen's formula, a well-established method for calculating the minimum sample size by incorporating key statistical parameters. These parameters include: 1) the effect size of the variable influencing self-directed learning, set at a moderate level of approximately .15, reflecting the influence of school context and teachers' personal backgrounds; 2) alpha, maintained at .05 to denote the probability at which the null hypothesis should be rejected; 3) a power of .95 indicating the probability of correctly detecting an effect if it exists; and 4) ANOVA statistics utilized for sample size computation, facilitated by the G*power program. The resulting minimum sample size, as determined by these calculations, was identified as 934 individuals. Employing a stratified random sampling method, facilitated by simple random sampling techniques, ensured proportional representation across distinct strata such as region, school affiliation, and school size.

Measurement Instruments

The measurement instruments utilized in the study encompassed three principal research variables: 1) Lifelong Learning Mindset (LLM), 2) Learning Habits (LH), and 3) Self-Directed Learning (SDL). The measurement constructs of the instruments were derived from the components outlined in the conceptual framework (Diagram 1).

Operational Definitions

Lifelong Learning Mindset (LLM) captures the cognitive, affective, and behavioral dimensions of teachers' attitudes towards lifelong learning, with implications for both personal and student development. LLM consists of three sub-components: M1, M2, and M3, as specified in the conceptual framework.

Learning habits (LH) denote ongoing behavioral patterns or actions aimed at fostering a disposition towards continuous personal development. LH consists of three sub-components: H1, H2, and H3, as specified in the conceptual framework.

Self-directed learning (SDL) involves a learning paradigm that emphasizes learner empowerment, autonomy in goal-setting, and selection of learning methodologies, as well as self-guidance throughout the learning process. SDL consists of five sub-components: S1, S2, S3, S4, and S5, as specified in the conceptual framework.

Measurement Instrument Types

In the initial phase of the study, the measurement instrument took the form of a ques-

tionnaire which utilized a Likert scale with five response levels to solicit teachers' perceptions regarding their learning environments. The questionnaire included three sets of questions: 10 items on LLM, 10 items on LH, and 15 items on SDL. Consequently, the complete questionnaire comprised a total of 35 items.

Data Collection

Data collection was conducted online using Google Forms. This process lasted approximately one month after receiving approval from the Research Ethics Review Committee for Research Involving Human Subjects at Chulalongkorn University on September 22, 2023. Following approval, consent was obtained from the research participants. Measures were taken to ensure anonymity, and participants were given flexibility to omit any questions they found inconvenient. The collected data were treated with the utmost confidentiality, and processing was conducted promptly.

Data collection, spanning approximately one month, yielded a total of 1,074 responses. After meticulous scrutiny and selection of only complete questionnaires from elementary school teachers, a pool of 943 valid questionnaires was prepared for analysis.

The data were further categorized based on school affiliation and size to ensure proportional representation across various categories. Notably, responses from teachers affiliated with the Bangkok Metropolitan Administration (BMA) were relatively lower compared to other affiliations. Regarding school size, a considerable proportion of respondents originated from large-sized schools, surpassing the numbers from small and medium-sized schools.

Examination of Instrument Quality

Content validity was evaluated by seven experts with expertise in adult learning, teacher development, and educational measurement and evaluation. Lawshe's formula (1975) was applied to compute the content validity ratio (CVR) for each item. Internal consistency reliabilities were assessed using Cronbach's alpha coefficient, while construct validity underwent scrutiny through exploratory factor analysis (EFA) in SPSS and confirmatory factor analysis (CFA) in the Mplus program. Model fit testing in the CFA analysis relied on Chi-square, CFI, TLI, SRMR, and RMSEA (Barrett, 2007; Hooper, Coughlan & Mullen, 2008). Given the chi-square statistic's sensitivity to sample size, Hu & Bentler (1999) cautioned that it may not always offer a definitive assessment of fit, recommending the inclusion of alternative fit indices such as RMSEA, CFI, and SRMR alongside chi-square to provide a more comprehensive evaluation. They underscored the importance of considering factors such as sample size and model complexity for an accurate interpretation of fit indices tailored to the specific study context.

RESULTS

The research was divided into two parts: Part 1 focused on the characteristics of the questionnaire after modification based on the expert opinions for each measurement item, while Part 2 examined the quality of the instruments.

Part 1 Characteristics of the Questionnaire

The details of the question sets presented for each variable (LLM, LH, and SDL) in the questionnaire following modification based on the opinions of qualified individuals, are shown in Tables 1-3, respectively.

Table 1 Questions for the LLM Scale after Modification

Items	Modified Questions Following Expert Opinions
1	I believe in continuous learning as a teacher's duty, staying updated and adapting to digital learning.
2	I connect continuous learning with achieving student development goals and professional advancement.
3	I believe in developing learning skills for a positive impact on student and professional progress.
4	I value staying informed about educational advancements for personal and student development.
5	I maintain an open mind and prioritize personal learning development.
6	I foster a positive attitude towards learning for creating suitable learning environments.
7	I willingly pursue self-development without feeling bound by educational goals or policies.
8	I show consistent interest in and seek to learn new things.
9	I demonstrate enthusiasm for adapting to the role of a modern teacher and learning about technology.
10	I display determination to learn for developing skills which can be applied to student development.

Table 2 Questions for the LH Scale after Modification

Items	Modified Questions Following Expert Opinions
11	I set goals for continuous self-development and to cultivate learning habits.
12	I establish learning goals beneficial to the teaching profession.
13	I set achievable goals with clear results in mind.
14	I specify methods for continuous learning goals.
15	I set small goals for short-term motivation and success.
16	I practice, follow guidelines, and monitor learning methods.
17	I review, adjust, and set new goals for specified learning objectives.
18	I allocate time for continuous learning amid responsibilities.
19	I am dedicated to personal learning for higher goals.
20	I create motivation and self-appreciation for advancement in the teaching profession.

Table 3 Questions for the SDL Scale after Modification

Items	Modified Questions Following Expert Opinions
21	I foster a positive mindset for independent learning and goal achievement.
22	I generate motivation or seek support for reinforcing continuous learning.
23	I find happiness in independent, self-guided learning and taking responsibility.
24	I analyze progress in my career path.
25	I know myself, recognizing learning needs for specific goals.
26	I analyze requirements, identifying strengths and weaknesses for development.
27	I set learning goals related to teaching or student challenges.
28	I set goals for elevating or acquiring new job performance skills.
29	I set challenging learning goals for student benefit.
30	I set effective learning methods suitable for myself.
31	I plan, manage, and control, solving problems according to a defined plan.
32	I use proactive learning, resources, and support, to achieve goals.
33	I transfer my learning to student development, analyzing and assessing the results.
34	I reflect on learning outcomes, improving learning and practices for job and personal development.
35	I continuously review, check, and evaluate the learning process for personal and professional growth

Part 2 Quality of the Instruments

The quality of the instruments was examined based on content validity, internal consistency reliability, and construct validity, as detailed below.

2.1 Content Validity

The content validity of the questionnaire was analyzed by assessing the relevance of each item with the operational definition based on seven expert opinions using the CVR (content validity ratio) developed by Lawshe (1975). The analysis revealed that out of the 35 items, 31 had a CVR of 1.00, while the remaining 4 items had a CVR of .71. The overall content validity index (S-CVI) was .97, showing a high level of content validity.

2.2 Internal Consistency Reliability

The internal consistency of the instrument was examined separately for the trial version (70 participants) and the in-use version (943 participants). The results are detailed as follows:

1) Lifelong Learning Mindset Scale: The trial version demonstrated internal consistency reliability values ranging from .871 to .902 for the subscales, with an overall reliability of .944. The in-use version showed reliability values between .840 and .874, with an overall reliability of .925.

2) Learning Habits Scale: The trial version exhibited internal consistency reliability values ranging from .783 to .881 for the subscales, with an overall reliability of .928. The in-use version showed internal consistency reliability values ranging from .861 to .912, with an overall reliability of .947.

3) Self-Directed Learning Scale: The trial version displayed internal consistency reliability values ranging from .834 to .889 for the subscales, with an overall reliability of .959. The in-use version showed internal consistency reliability values ranging from .842 to .901, with an overall reliability of .963.

Table 4 The Internal Consistency Reliability Values of the Measurement Instrument

Variables	Number of Items	Trial Version Reliability	In-Use Version Reliability
1. Lifelong Learning Mindset Scale			
1.1 Perception of the importance of self-learning development	4	.902	.862
1.2 A positive attitude towards lifelong learning	3	.885	.840
1.3 Determination and commitment to learning	3	.871	.874
Internal Consistency Reliability of LLL Scale	**10**	**.944**	**.925**
2. Learning Habits Scale			
2.1 Goal setting for cultivating positive learning habits	4	.881	.912
2.2 Engaging in self-practice to attain learning objectives	3	.783	.867
2.3 Maintaining continuous learning until it becomes a habit	3	.877	.861
Internal Consistency Reliability of LH Scale	**10**	**.928**	**.947**
3. Self-Directed Learning Scale			
3.1 Creating a learning climate for oneself	3	.837	.842
3.2 Diagnosing learning needs	3	.842	.880

Table 4 (Continued)

Variables	Number of Items	Trial Version Reliability	In-Use Version Reliability
3.3 Setting learning goals	3	.863	.901
3.4 Planning and managing learning	3	.834	.890
3.5 Evaluating and reflecting on the learning experience	3	.889	.844
Internal Consistency Reliability of SDL Scale	**15**	**.959**	**.963**

2.3 Construct Validity

Construct validity analysis employs two methods of component analysis, specifically 1) Exploratory Factor Analysis (EFA): Conducted on real data from 943 individuals, this analysis utilized principal component analysis and varimax rotation, and 2) Confirmatory Factor Analysis (CFA): Conducted using the Mplus program, CFA aimed to confirm the construct validity. The analysis yielded the following details for the three variables.

1) Lifelong Learning Mindset

Table 5 presents the mean values for LLM. The 10 items of the LLM variable were categorized into three sub-components, namely M1: Perception of the importance of self-learning development (4 items), M2: A positive attitude towards lifelong learning (3 items), and M3: Determination and commitment to learning (3 items). The results show that the factor loadings for each item were statistically significant at the .05 level, with positive directions. The magnitudes of the relationships ranged from .424 to .770, showing moderate to strong correlations. The value of the Kaiser-Meyer-Olkin (KMO) measure was .933, indicating adequate interrelatedness among the variables for factor analysis.

Table 5 Correlation Coefficients Matrix for LLM

Items	1	2	3	4	5	6	7	8	9	10
M1: Perception of the importance of self-learning development										
1) I believe in continuous learning as a teacher's duty, staying updated and adapting to digital learning.	1.000									
2) I connect continuous learning with achieving student development goals and professional advancement.	.770	1.000								
3) I believe in developing learning skills for a positive impact on students and professional progress.	.602	.694	1.000							
4) I value staying informed about educational advancements for personal and student development.	.688	.715	.708	1.000						
M2: A positive attitude towards lifelong learning										
5) I maintain an open mind and prioritize personal learning development.	.451	.545	.544	.555	1.000					

Table 5 (Continued)

Items	1	2	3	4	5	6	7	8	9	10
6) I foster a positive attitude towards learning for creating suitable learning environments.	.542	.526	.612	.607	.717	1.000				
7) I willingly pursue self-development without feeling bound by educational goals or policies.	.701	.697	.675	.697	.680	.760	1.000			
M3: Determination and commitment to learning										
8) I show consistent interest in and seek to learn new things.	.640	.665	.594	.643	.680	.610	.729	1.000		
9) I demonstrate enthusiasm for adapting to the role of a modern teacher and learning about technology.	.579	.424	.501	.533	.577	.576	.633	.633	1.000	
10) I display determination to learn for developing skills which can be applied to student development.	.606	.591	.593	.563	.656	.693	.673	.733	.710	1.000
LLM scale										
M	**4.65**	**4.62**	**4.56**	**4.63**	**4.55**	**4.61**	**4.50**	**4.48**	**4.46**	**4.61**
SD	**.583**	**.590**	**.595**	**.585**	**.602**	**.566**	**.643**	**.659**	**.647**	**.569**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .933

Bartlett's Test of Sphericity Approx. Chi-Square = 5962.249, df = 45, n= 943, p <.01

Table 6 presents the results of the Exploratory Factor Analysis (EFA) for the variable "LLM." It reveals that there is one factor explaining 59.875% of the variance.

Table 6 Percentage of Variance Explained by the Factor Analysis of LLM

Components	Initial Eigen Values			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.988	59.875	59.875	5.988	59.875	59.875
2	1.060	10.600	70.475			
3	.520	5.202	75.677			
4	.465	4.646	80.324			
5	.412	4.116	84.440			
6	.387	3.869	88.309			
7	.335	3.345	91.654			
8	.309	3.095	94.749			
9	.282	2.822	97.571			
10	.243	2.429	100.000			

Table 7 displays the factor loadings for the first component, with weights ranging from .703 to .832 across all 10 items. This set of components is termed the "LLM."

Table 7 Factor Loadings for LLM after Varimax Rotation

	Items	Factor Loadings
6	I foster a positive attitude towards learning for creating suitable learning environments.	**.832**
10	I display determination to learn for developing skills which can be applied to student development.	**.806**
8	I show consistent interest in and seek to learn new things.	**.785**
9	I demonstrate enthusiasm for adapting to the role of a modern teacher and learning about technology.	**.785**
5	I maintain an open mind and prioritize personal learning development.	**.783**
7	I willingly pursue self-development without feeling bound by educational goals or policies.	**.773**
3	I believe in developing learning skills for a positive impact on student and professional progress.	**.769**
4	I value staying informed about educational advancements for personal and student development.	**.767**
2	I connect continuous learning with achieving student development goals and professional advancement.	**.727**
1	I believe in continuous learning as a teacher's duty, staying updated and adapting to digital learning.	**.703**

Note. Items are listed in order of factor loadings.

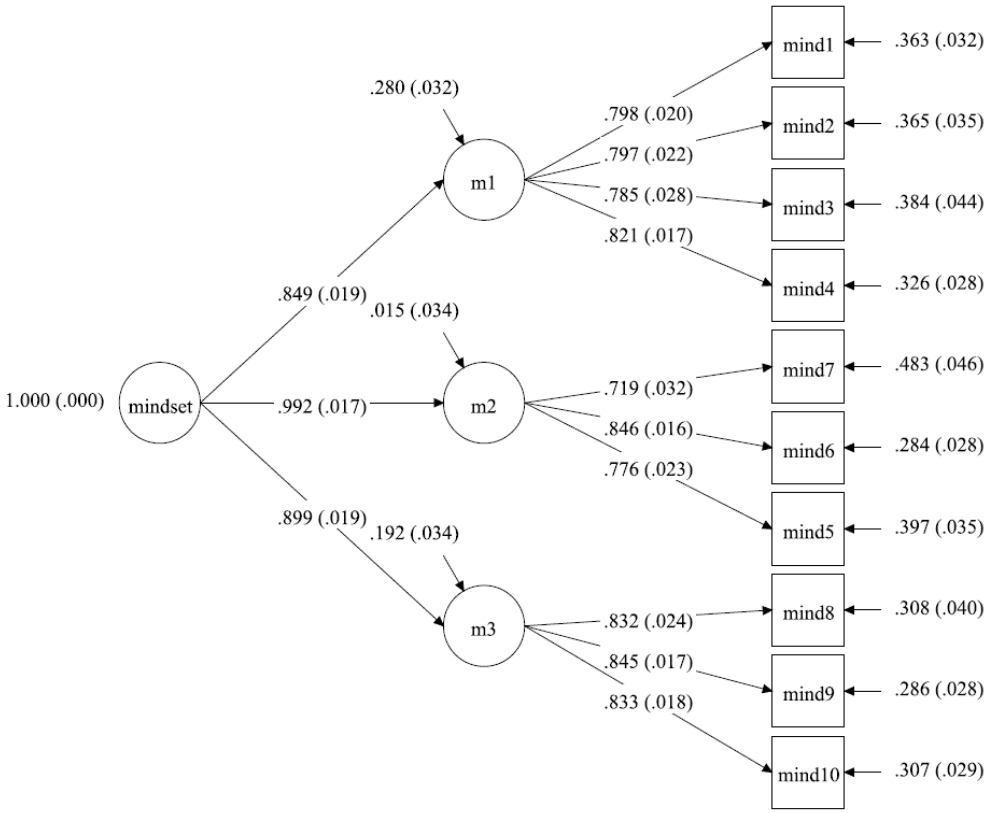
For the CFA results using the Mplus program, Chi-Square = 90.337, df = 33, p = .000, CFI = .974, TLI = .964, SRMR = .119, RMSEA = .043. Although the p-value is below .05 the Chi/df is less than 5 times. CFI and TLI values exceed the cut-off of .9, while SRMR and RMSEA are both relatively low. These values collectively suggest that the measurement model aligns well with the observational data, requiring no further adjustments (Barrett, 2007; Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999).

Examining the weights in Figure 1 reveals that the LLM variable is comprised of three distinct sub-components. Each of these sub-components exhibits weights closely clustered between .849 and .992. Notably, M2: A positive attitude towards lifelong learning holds the highest weight at .992, followed by M3: Determination and commitment to learning at .899, and M1: Perception of the importance of self-learning development, which carries the lowest weight at .849. Furthermore, the weights of the indicators within each sub-component demonstrate similar values. This analysis confirms the construct validity of the measurement instrument for the LLM variable based on the three specified sub-components.

2) Learning Habits

Table 8 displays the mean values for the 10 items of the LH variable, which were categorized into three sub-components: H1: Goal setting for cultivating positive learning habits (4 items), H2: Engaging in self-practice to attain learning objectives (3 items), and H3: Maintaining continuous learning until it becomes a habit (3 items). The inter-item correlation coefficients for the LH variable showed statistically significant positive relationships at the .05 level. The magnitudes of the relationships ranged from .546 to .790, showing at least a moderate level of correlation. The calculated KMO value was .951, which was found to be significant at the .05 level, suggesting that the variables were sufficiently correlated for factor analysis.

Figure 1 Results of the Confirmatory Factor Analysis for LLM



Chi-Square = 90.337, df = 33, p = .000, CFI = .974, TLI = .964, SRMR = .119, RMSEA = .043

Table 8 Correlation Coefficients Matrix for LH

Items	1	2	3	4	5	6	7	8	9	10
H1: Goal setting for cultivating positive learning habits										
1) I set goals for continuous self-development and cultivate learning habits.	1.000									
2) I establish learning goals beneficial to the teaching profession.	.712	1.000								
3) I set achievable goals with clear results in mind.	.715	.733	1.000							
4) I specify methods for continuous learning goals.	.719	.669	.790	1.000						
H2: Engaging in self-practice to attain learning objectives										
5) I set small goals for short-term motivation and success.	.561	.546	.598	.632	1.000					
6) I practice, follow guidelines, and monitor learning methods.	.632	.592	.627	.683	.657	1.000				
7) I review, adjust, and set new goals for specified learning objectives.	.629	.600	.662	.692	.633	.767	1.000			

Table 8 (Continued)

H3: Maintaining continuous learning until it becomes a habit										
8) I allocate time for continuous learning amid responsibilities.	.638	.606	.651	.659	.559	.697	.701	1.000		
9) I am dedicated to personal learning to achieve higher goals.	.594	.591	.594	.595	.550	.643	.626	.715	1.000	
10) I create motivation and self-appreciation for advancement in the teaching profession.	.607	.623	.612	.630	.567	.648	.627	.652	.656	1.000
LH scale										
M	**4.37**	**4.46**	**4.38**	**4.34**	**4.32**	**4.24**	**4.22**	**4.31**	**4.40**	**4.38**
SD	**.658**	**.655**	**.680**	**.677**	**.683**	**.695**	**.716**	**.697**	**.683**	**.666**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .951
Bartlett's Test of Sphericity Approx. Chi-Square = 7494.390, df = 45, n = 943, p < .01

Table 9 presents the results of the Exploratory Factor Analysis (EFA) for LH. This reveals that the first component, termed overall LH, explains 67.856% of the variance.

Table 9 Percentage of Variance Explained According to the Factor Analysis of LH

Components	**Initial Eigen Values**			**Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.786	67.856	67.856	6.786	67.856	67.856
2	.636	6.358	74.215			
3	.536	5.361	79.576			
4	.411	4.112	83.687			
5	.351	3.506	87.193			
6	.316	3.158	90.352			
7	.292	2.920	93.271			
8	.258	2.580	95.851			
9	.227	2.265	98.117			
10	.188	1.883	100.000			

Table 10 displays the factor loadings for the first component, with weights ranging from .762 to .861 across all 10 items. This component is termed LH.

Table 10 Factor Loadings for LH after Varimax Rotation

	Items	**Factor Loadings**
4	I specify methods for continuous learning goals.	**.861**
3	I set achievable goals with clear results in mind.	**.850**
6	I practice, follow guidelines, and monitor learning methods.	**.844**
7	I review, adjust, and set new goals for specified learning objectives.	**.844**
8	I allocate time for continuous learning amid responsibilities.	**.836**
1	I set goals for continuous self-development and cultivate learning habits.	**.828**

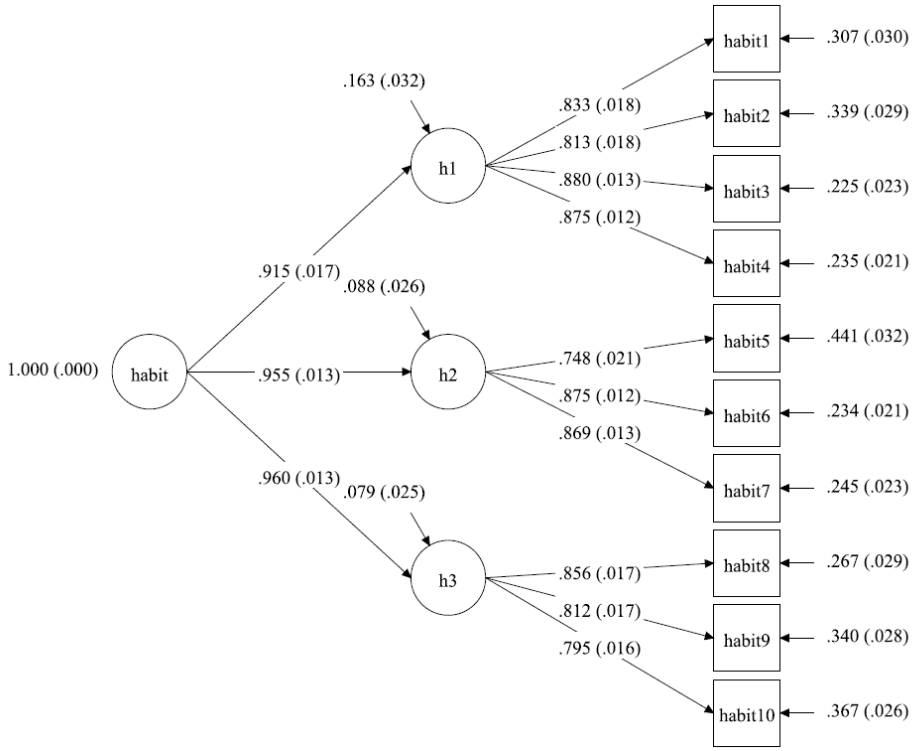
Table 10 (Continued)

	Items	Factor Loadings
2	I establish learning goals beneficial to the teaching profession.	**.810**
10	I create motivation and self-appreciation for advancement in the teaching profession.	**.803**
9	I am dedicated to personal learning to achieve higher goals.	**.795**
5	I set small goals for short-term motivation and success.	**.762**

Note. Items are listed in order of factor loadings.

For the CFA results using the Mplus program, Chi-Square = 72.878, df = 32, p = .000, CFI = .988, TLI = .982, SRMR = .019, and RMSEA = .037. Although the p-value is below .05, the Chi/df is less than 5 times, CFI and TLI values exceed .9, and SRMR and RMSEA are both relatively low. These results collectively suggest that the measurement model aligns well with the observational data, requiring no further adjustments (Barrett, 2007; Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999).

Figure 2 Results of Confirmatory Factor Analysis for LH



Chi-Square = 72.878, df = 32, p = .000, CFI = .988, TLI = .982, SRMR = .019, RMSEA = .037

These findings collectively indicate that the measurement model aligns well with the observational data, necessitating no further adjustments. Upon examination of the weights depicted in Figure 2, it is evident that the LH variable is comprised of three distinct sub-components. These three sub-components demonstrate weights closely clustered between .915 and .960. Particularly noteworthy is the sub-component labeled H3: Maintaining continuous learning until it becomes a habit, which exhibits the highest weight at .960. This is followed by H2: Engaging in self-practice to attain learning objectives, which holds a weight of .955. Finally, H1: Goal setting for cultivating positive learning habits, yielded the lowest weight at .915. Additionally, the weights of the indicators within each sub-component displayed similar values. This analysis confirms the construct validity of the measurement instrument for the LH variable, based on the three defined sub-components.

3) Self-Directed Learning

Table 11 presents the mean values of the SDL variable, consisting of 15 items categorized into five sub-components: S1: Creating a learning climate for oneself; S2: Diagnosing learning needs; S3: Setting learning goals; S4: Planning and managing learning; and S5: Evaluating and reflecting on the learning experience. Each sub-component is composed of three items. The inter-item correlation coefficients for the SDL variable showed statistically significant positive relationships at the .05 level. The magnitudes of the relationships ranged from .520 to .782, showing at least a moderate level of correlation. The KMO value was calculated to be .970, suggesting that the variables were sufficiently correlated for factor analysis.

Table 11 Correlation Coefficients Matrix for SDL

Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S1: Creating a learning climate for oneself															
1) I foster a positive mindset for independent learning and goal achievement.	1.00														
2) I generate motivation or seek support for reinforcing continuous learning.	.651	1.00													
3) I find happiness in independent, self-guided learning and taking responsibility.	.636	.635	1.00												
S2: Diagnosing learning needs															
4) I analyze progress in my career path	.635	.629	.690	1.00											
5) I know myself, recognizing learning needs for specific goals.	.585	.566	.698	.726	1.00										
6) I analyze requirements, identifying strengths and weaknesses for development.	.626	.596	.682	.697	.707	1.00									
S3: Setting learning goals															
7) I set learning goals related to teaching or student challenges.	.638	.589	.650	.641	.649	.782	1.00								
8) I set goals for elevating or acquiring new job performance skills.	.609	.599	.607	.623	.642	.712	.769	1.00							
9) I set challenging learning goals for student benefit.	.627	.603	.624	.637	.626	.688	.744	.741	1.00						

Table 11 (Continued)

Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S4: Planning and managing learning															
10) I set effective learning methods suitable for myself.	.606	.561	.624	.582	.624	.658	.702	.675	.696	1.00					
11) I plan, manage, and control, solving problems according to a defined plan.	.574	.563	.617	.574	.601	.650	.677	.675	.681	.727	1.00				
12) I use proactive learning, resources, and support to achieve goals.	.603	.546	.611	.575	.600	.671	.646	.654	.648	.715	.746	1.00			
S5: Evaluating and reflecting on the learning experience															
13) I transfer learning to student development, analyzing and assessing the results.	.612	.520	.617	.571	.587	.664	.662	.639	.680	.690	.698	.774	1.00		
14) I reflect on learning outcomes, to improve learning and practices for job and personal development.	.609	.539	.601	.556	.555	.574	.612	.567	.554	.557	.561	.528	.574	1.00	
15) I continuously review, check, and evaluate the learning process for personal and professional growth	.582	.521	.599	.577	.587	.665	.688	.665	.679	.676	.691	.720	.769	.586	1.00
SDL scale															
M	**4.31**	**4.42**	**4.23**	**4.37**	**4.29**	**4.29**	**4.28**	**4.32**	**4.34**	**4.28**	**4.20**	**4.21**	**4.24**	**4.13**	**4.24**
SD	**.690**	**.647**	**.722**	**.668**	**.700**	**.699**	**.688**	**.684**	**.687**	**.694**	**.720**	**.738**	**.716**	**.781**	**.742**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .970
Bartlett's Test of Sphericity Approx. Chi-Square = 12362.149, df = 45, n = 943, p < .01

Table 12 displays the results of the Exploratory Factor Analysis (EFA) for the SDL variable. It reveals that the first component, termed SDL, explains 66.114% of the variance.

Table 12 Percentage of Variance Explained According to the Factor Analysis of SDL

Components	Initial Eigen Values			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.917	66.114	66.114	9.917	66.114	66.114
2	.835	5.568	71.681			
3	.561	3.741	75.423			
4	.499	3.327	78.750			

Table 12 (Continued)

Components	Initial Eigen Values			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
5	.481	3.204	81.954			
6	.380	2.533	84.487			
7	.335	2.236	86.723			
8	.311	2.070	88.793			
9	.301	2.008	90.801			
10	.268	1.788	92.589			
11	.263	1.754	94.343			
12	.242	1.611	95.954			
13	.234	1.557	97.511			
14	.194	1.293	98.804			
15	.179	1.196	100.000			

Table 13 presents the factor loadings for the first component, with weights ranging from .732 to .860 across all 15 items. This component is termed the "SDL."

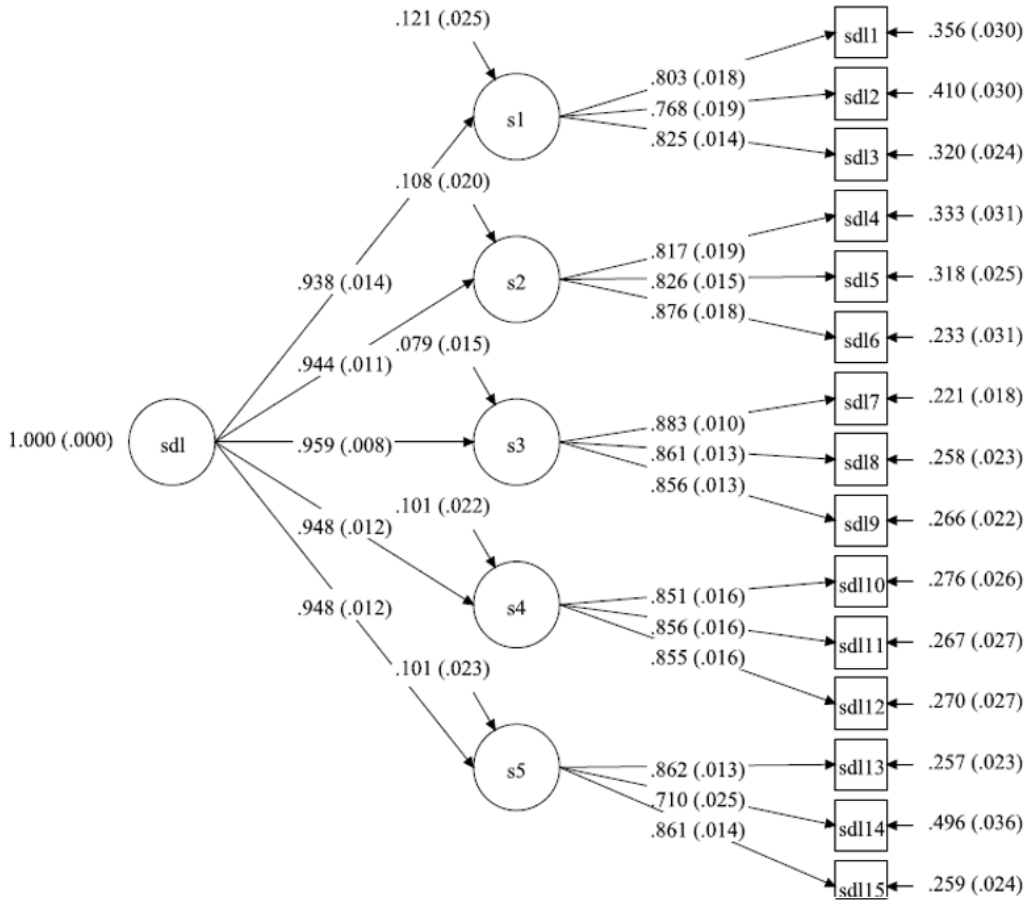
Table 13 Factor Loadings for SDL after Varimax Rotation

	Items	Factor Loadings
7	I set learning goals related to teaching or student challenges.	**.860**
6	I analyze requirements, identifying strengths and weaknesses for development.	**.853**
9	I set challenging learning goals for student benefit.	**.841**
8	I set goals for elevating or acquiring new job performance skills.	**.837**
10	I set effective learning methods suitable for myself.	**.830**
13	I transfer learning to enhance student development, analyzing and assessing the results.	**.827**
11	I plan, manage, and control, solving problems according to a defined plan.	**.825**
12	I use proactive learning, resources, and support to achieve goals.	**.825**
15	I continuously review, check, and evaluate the learning process for personal and professional growth	**.822**
3	I find happiness in independent, self-guided learning and taking responsibility.	**.810**
5	I know myself, recognizing learning needs for specific goals.	**.800**
4	I analyze progress in my career path	**.795**
1	I foster a positive mindset for independent learning and goal achievement.	**.785**
2	I generate motivation or seek support for reinforcing continuous learning.	**.744**
14	I reflect on learning outcomes, to improve learning and practices for job and personal development.	**.732**

Note. Items are listed in order of factor loadings.

For the CFA results using the Mplus program, Chi-Square = 385.534, df = 85, p = .000, CFI = .956, TLI = .946, SRMR = .031, RMSEA = .061. Although the p-value is below .05, the Chi/df is less than 5 times, the CFI and TLI values exceed .9, SRMR and RMSEA are both relatively low. These results collectively suggest that the measurement model aligns well with the observational data, requiring no further adjustments (Barrett, 2007; Hooper, Coughlan & Mullen, 2008; Hu & Bentler, 1999).

Figure 3 Results of Confirmatory Factor Analysis for SDL



Chi-Square = 385.534, df = 85, p =.000, CFI = .956, TLI = .946, SRMR = .031, RMSEA = .061

Examining the weights in Figure 3 reveals that the SDL variable comprises five distinct sub-components. Each of these demonstrates weights closely clustered between .938 and .959. Notably, the sub-component labeled S3: Setting learning goals, carries the highest weight at .959, followed by S4: Planning and managing learning and S5: Evaluating and reflecting on the learning experience, both of which yielded a weight of .948. The sub-component S2: Diagnosing learning needs, follows with a weight of .944, and S1: Creating a learning climate for oneself, yielded the lowest weight at .938. Additionally, the weights of indicators within each sub-component displayed similar values. This analysis confirms the construct validity of the measurement instrument for the SDL variable, based on the five defined sub-components.

4) Percentile Norms

Table 14 shows the score distribution for establishing percentile norms for score interpretation. For the variables LLM, LH, and SDL, the average scores were 4.57, 4.34, and 4.28, respectively. The skewness values of all variables were negative, indicating that the data were not symmetrical. The negative skewness means that most people receive high scores. The LLM variable (-1.08) has a more negative skewness than the other two variables. For the LLM variable, the kurtosis value was positive (0.82), showing that the scores were clustered together and had a high score. The kurtosis of the LH variable (-0.26) and the SDL variable (0.05) had negative values and were close to zero. This shows that the scores on these two variables are quite symmetrical. The descriptive statistics and score distributions for all three variables are shown in table 14, below.

Table 14 Distribution of Scores for Establishing Norms

Variables	M	SD	Min	Max	Mdn	Mo	SK	SE.SK	Ku	SE. Ku
1. Lifelong Learning Mindset	**4.57**	**0.47**	**2.80**	**5.00**	**4.70**	**5.00**	**-1.08**	**0.08**	**0.82**	**0.16**
1.1 Perception of the importance of self-learning development	4.62	0.49								
1.2 Positive attitude towards lifelong learning	4.55	0.53								
1.3 Determination and commitment to learning	4.51	0.56								
2. Learning Habits	**4.34**	**0.56**	**2.00**	**5.00**	**4.40**	**5.00**	**-0.57**	**0.08**	**-0.26**	**0.16**
2.1 Goal setting for cultivating positive learning habits	4.39	0.59								
2.2 Engaging in self-practice to attain learning objectives	4.26	0.62								
2.3 Maintaining continuous learning until it becomes a habit	4.36	0.60								
3. Self-Directed Learning	**4.28**	**0.57**	**1.80**	**5.00**	**4.27**	**5.00**	**-0.56**	**0.08**	**0.05**	**0.16**
3.1 Creating a learning climate for oneself	4.32	0.60								
3.2 Diagnosing learning needs	4.32	0.62								
3.3 Setting learning goals	4.31	0.63								
3.4 Planning and managing learning	4.23	0.65								
3.5 Evaluating and reflecting on the learning experience	4.20	0.65								

Note. n = 943 participants

Table 15 presents the percentile norms for all three variables, namely LLM, LH, and SDL. The 50th percentile scores for these variables were 4.70, 4.40, and 4.27, respectively.

Table 15 Percentile Norms for LLM, LH, and SDL

Percentiles	LLM	LH	SDL
10	4.00	3.60	3.53
20	4.10	3.90	3.87
30	4.40	4.00	4.00
40	4.50	4.10	4.07
50	4.70	4.40	4.27
60	4.90	4.60	4.47
70	5.00	4.80	4.67
80	5.00	5.00	4.93
90	5.00	5.00	5.00

Note. n = 943 participants

DISCUSSION AND CONCLUSION

The measurement instruments crafted for assessing LLM, LH, and SDL in this study all exhibited notable empirical robustness, underscoring their efficacy for evaluating the characteristics of lifelong learners, especially within the educational context.

The item content validity ratio (CVR) for the developed instruments, thoroughly assessed by a panel of qualified experts, consistently surpassed the conventional threshold, ranging between .71 and 1.00. This signifies a high level of agreement among experts regarding the relevance and representativeness of the items within each instrument. Such CVR ensures the instrument's ability to effectively capture the intended definitions of LLM, LH, and SDL (Lawshe, 1975). Moreover, the internal consistency reliability of the instruments, as gauged by the Cronbach's alpha coefficient, yielded commendable values ranging from .925 to .963 across the different subscales. These findings indicate a high degree of internal coherence and consistency within each variable subscale, suggesting that the items within each subscale were measuring the same construct.

The internal consistency reinforces the instrument's suitability for capturing the nuances of lifelong learning characteristics among teachers. Furthermore, confirmatory factor analysis (CFA), conducted using the Mplus program corroborates the alignment of all variables with their respective theoretical models at a significance level of .05. This statistical validation underscores the fidelity of the developed instruments to their underlying theoretical frameworks, affirming their construct validity and ensuring that they effectively measure the targeted dimensions of LLM, LH, and SDL.

This research lays the groundwork for future investigations that can build upon its findings and extend beyond its current scope. One avenue for further exploration lies in the methodology utilized for constructing indices such as the learning index (Harth, Wongwanich & Piromsombat, 2023) or digital learning (Kim et al., 2023; Kitcharoen, 2021). Moreover, while this study employed a traditional factor-based approach, an alternative method known as component-based analysis has gained traction in recent research endeavors (Chumwichan, Wongwanich & Piromsombat, 2023).

Since the developed instrument was intended for use by all teachers, it is recommended to conduct a replicate study for the group of secondary school teachers to establish percentile norms for that group. Furthermore, an avenue for future research lies in utilizing the proposed scale to enhance lifelong learning motivation (LLM), learning habits (LH), and self-directed learning (SDL) among teachers.

RECOMMENDATIONS

1. The measurement instruments developed from this study to measure LLM, LH, and SDL are of high quality. They can also provide information to promote the professional development of teachers towards lifelong learning.
2. The measurement instrument development is intended to be used for both elementary and secondary school teachers. Therefore, replicating the study for a group of secondary school teachers is recommended, along with establishing percentile norms for that group.

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NOTES

This research has undergone ethical considerations by the Research Ethics Committee for Human Research, Group 2, Social Sciences, Humanities, and Fine Arts, Chulalongkorn University, by the certification document with reference number COA No. 356/66, Project No. 660318.

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