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Establishing Reliable Measures for Examining the Mediating Role of Teachers' Innovative Leadership in Transformational Leadership and Continuing Professional Development

Lu Yan[1,2] & Fanny Kho Chee Yuet[1]

[1]Department of Educational Management, Faculty of Management and Economics, Sultan Idris Education University, Malaysia, [2]Nanning Normal University, Nanning, China

Corresponding Author Email: fannykcy@fpe.upsi.edu.my

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Abstract

Teachers must pursue continuing professional development to effectively address the changing demands and challenges of education, given the speed at which the educational landscape is changing today. This is crucial for enhancing teaching quality and adapting to educational transformations. Therefore, based on a comprehensive literature review and theoretical analysis, this study identified relevant constructs and variables. Reliable measurement scales were then adapted to establishing reliable measures for examining the mediating role of teachers' innovative leadership in transformational leadership and continuing professional development. Using a sample of 125 demonstrative high school teachers from Guangxi, China, data were collected via questionnaires. Exploratory and Confirmatory Factor Analyses confirmed the construct validity, while high internal consistency (Cronbach's Alpha > 0.9) indicated strong reliability. In total, the questionnaire was confirmed as effective and reliable, successfully retaining 62 out of the original 69 items. This study provides important practical insights for further research on educational leadership and teachers continuing professional development and offers valuable references for principals on how to effectively motivate and support teachers' innovation and growth in practice.

Keywords: Transformational Leadership, Innovative Leadership, Continuing Professional Development, Questionnaire Adaptation, Demonstrative High Schools

Introduction

With the development of society and the continuing advancement of educational reforms, teachers need to constantly update their professional capabilities and improve their professional skills to meet the needs of modern education. However, not all teachers possess the ability to cope with these changes, such as changes in teaching methods and tools, which have put enormous pressure on them (Granziera et al., 2019). The purpose of Teacher Continuing Professional Development (TCPD) is to help teachers adapt to the changes and

demands of the times and appropriately fulfil their responsibilities (Tyagi & Misra, 2021). Despite the high emphasis on professional development in national policies and the achievements in educational development, effective continuing professional development still faces significant obstacles. For example, the Chinese government's "Education Modernization Plan 2035" aims to improve teachers' quality through continuing professional development. However, there are numerous challenges in actual implementation.

Teachers often work in a hierarchical school culture, facing pressures from reforms, exams, student performance, parent communication, performance evaluations, and promotion prospects, which limit their space for broader educational reflection and innovation. In addition to the school culture not being conducive to teachers' continuing professional development, another major challenge is the lack of sufficient support and guidance from principals, which can make teachers feel unsupported. Without a coherent leadership structure, teachers may find it difficult to take initiative and adopt innovative practices (Buyukgoze et al., 2022). Therefore, promoting teachers' continuing professional development has become an urgent reform issue.

Existing literature suggests that principal's transformational leadership can significantly enhance teachers' professional development and innovative abilities, thereby improving the overall teaching quality of schools. For example, Wang (2021) indicated that principal's transformational leadership indirectly affects students' modernity by enhancing school climate and teacher quality. Furthermore, Karacabey et al. (2020) explored how principal's transformational leadership influences teachers' professional learning through collective teacher efficacy and trust. Although these studies provide rich theoretical support, they mainly focus on educational contexts in Western countries and lack exploration of the Chinese educational system.

In recent years, Innovative Leadership (IL), as a derivative form of Transformational Leadership (TL), has gradually become an important issue in educational management. Innovative leadership not only emphasizes the motivational role of leaders but also focuses on promoting educational innovation, changing traditional teaching methods, and encouraging teachers to explore and adopt new educational ideas and technologies (Putro et al., 2023). Innovative leadership is closely related to transformational leadership, as both focus on enhancing teachers' self-development and sense of engagement, but IL places more emphasis on innovative thinking and practices (Kilag et al., 2023; Vermeulen et al., 2022). Teacher innovative leadership plays a crucial role in improving educational quality and driving school development. However, past research has provided little evidence to suggest that teacher innovative leadership mediates the impact of transformational leadership by principals on teachers' continuing professional development.

Literature Review

Transformational Leadership

Transformational leadership is a widely recognized leadership theory, initially proposed by Burns in 1978 and later expanded by Bernard M. Bass. Bass identified four core dimensions of transformational leadership: idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. The four-dimensional structure of Bass's transformational leadership model has been widely accepted, and the Multifactor Leadership

Questionnaire (MLQ) was developed as a tool to measure it. However, some empirical studies have raised concerns about the content and structural validity of this model. For example, Carless argued that transformational leadership should be considered a single dimension rather than multiple dimensions (Carless et al., 2000). Over the past two decades, the principal's transformational leadership scales have garnered significant attention. Despite the variety of available scales for measuring transformational leadership, most of them have been developed within a Western cultural context (e.g., Bass & Avolio, 1995; Carless et al., 2000). While these scales generally exhibit high reliability and validity, their measurement dimensions and item content may lack cultural applicability in the Chinese educational context. This is particularly true for dimensions related to "moral example" and "leadership charisma," where Chinese culture has unique expectations of leadership roles. As a result, these scales may not fully or accurately capture the performance of Chinese principals in transformational leadership. This limitation presents a challenge in selecting appropriate measurement tools for this study.

The primary focus of this study is to explore the impact of principal's transformational leadership on teacher continuing professional development and to examine the mediating role of teachers' innovative leadership. To accurately measure the performance of principal's transformational leadership in the Chinese educational context, it is essential to select a scale that reflects the unique cultural factors of China. The scale developed by Li Chaoping and Shi Kan (2005) is advantageous in terms of cultural fit and is grounded in the classical transformational leadership theory. This scale has been validated in the Chinese business management context and includes measurement dimensions that align with Chinese management culture, such as moral example, vision-based motivation, and individualized consideration. These dimensions closely match the variables of this study (Li & Shi, 2005).

Innovative Leadership

Most studies on the impact of leadership on innovation are conducted within the conceptual framework of existing leadership styles, such as transformational leadership, strategic leadership, and empowering leadership. These leadership styles related to innovation can, to some extent, influence creativity and innovative performance within organizations. However, these existing leadership styles are unlikely to fully capture the complexity and dynamics of Innovative leadership, as they primarily focus on other non-innovative aspects of leadership. The existing literature seems to acknowledge the innovative nature of leadership, but empirical research on Innovative leadership is limited due to insufficient theoretical conceptualization and the lack of reliable measurements for Innovative leadership (Zhu et al., 2024).

To gain a deeper understanding of the measurement tools for Innovative leadership, this paper provides a comprehensive review of existing Innovative leadership scales. Research on innovative leadership explores various dimensions and measurement methods. Khalili (2017) focuses on creativity and individual support, using a 24-item Likert scale, while Kremer et al. (2019) emphasize best practices without a scale. Kemer & Öztürk (2021) highlight qualities such as energy and entrepreneurial spirit in nursing leadership, using a 43-item scale. Contreras et al. (2022) focus on promoting learning and a safe environment for change, employing a 16-item scale. Ariratana et al. (2019) cover transformational vision, creative thinking, teamwork and participation, morality and accountability, risk management, and an

innovative organizational climate in educational management, using a 42-item scale. Zhu et al. (2024) examine organizational leadership using a multi-dimensional scale that emphasizes creativity, innovation, and the implementation of new ideas. Collectively, these studies evaluate leadership through diverse frameworks and methodologies, spanning structured item scales to best-practice guidelines.

Given the robust psychometric validation and comprehensive framework of the Innovative Leadership Measure (ILM) developed by Zhu et al. (2024), it serves as an ideal reference tool for this study. The ILM not only captures the cognitive and behavioral dimensions of Innovative leadership, such as creative thinking and tolerance for risk, but also focuses on motivational and structural elements, such as the will to innovate and the establishment of innovation mechanisms. Compared to other scales that may focus on narrower constructs, this holistic approach allows for a more detailed and comprehensive assessment of Innovative leadership. Furthermore, the ILM has been validated in diverse cultural contexts, including China and the United States, demonstrating its broad applicability and effectiveness. Therefore, this study will adapt the ILM to suit the educational context, using it as a measurement tool to assess teachers' Innovative leadership.

Continuing Professional Development

In the field of teachers' Continuing Professional Development (CPD), various scales have been developed to systematically assess teachers' professional growth and participation across different dimensions. For example, Bozkuş (2019) designed a scale to evaluate teaching effectiveness and student interaction from the students' perspective, with high reliability (Cronbach's $\alpha > 0.85$). Alzahrani & Nor (2021) focused on EFL teachers' attitudes toward CPD programs, with their scale also showing reliability (Cronbach's $\alpha > 0.80$). Vries, Jansen, and van de Grift (2013) developed a scale that assesses teachers' professional growth across multiple dimensions, demonstrating high reliability and validity (Cronbach's $\alpha > 0.80$). Soine & Lumpe (2014) created a scale that emphasizes teachers' application of knowledge and teaching activities, although it is relatively weak in assessing reflective activities. The scale proposed by Behzadi et al. (2019) is tailored for the EFL environment in Iran, showing high reliability (Cronbach's $\alpha = 0.90$). Evers et al. (2015) developed the TPD@Work scale to evaluate teachers' professional development in the workplace, highlighting the interactive and sustained nature of teachers' growth in the work environment. These scales provide effective tools for assessing teachers' professional growth in various educational contexts and cultural settings. However, they fail to comprehensively cover the key activities of CPD, especially the measurement needs for "sustainability" and "innovative leadership." The scale developed by Vries et al. (2013), which comprehensively evaluates teachers' continuing professional development, is particularly suitable for exploring the role of principal's transformational leadership and teachers' innovative leadership in CPD and has been validated in the Chinese context (Zhang et al., 2024). These features make the scale an ideal measurement tool for this study, supporting the exploration of the relationship between principal's leadership, teachers' innovative leadership, and continuing professional development.

Theoretical Framework

This study is based on several theoretical frameworks: the principal's transformational leadership style is grounded in transformational leadership theory, which emphasizes

motivating teachers to transcend self-interest and work collectively to achieve organizational goals, thereby enhancing overall school performance (Bass, 1985; Bass & Avolio, 1995). The theoretical foundation of teacher Innovative leadership is based on innovative leadership theory, which focuses on cultivating teachers' creative thinking, tolerance for risk, and openness to diverse perspectives, thus fostering the innovative development of schools (Zhu et al., 2024). Teacher continuing professional development is based on adult learning theory, which highlights the self-directed nature of adult learners, who tend to focus on acquiring knowledge and skills closely related to their work and life, promoting the ongoing enhancement of teachers' capabilities (Carney, 1986). Furthermore, distributed leadership theory supports the study of how the principal's transformational leadership influences teacher Innovative leadership, emphasizing the decentralization of leadership functions across various levels of the organization, facilitating collaboration and interaction among teachers, and enhancing the team's innovative capacity (Spillane et al., 2001). Social exchange theory explains how the principal's transformational leadership builds trust, empowers, and supports teachers, motivating them to actively engage in professional development activities, thereby increasing their job satisfaction and self-efficacy (Cropanzano & Mitchell, 2005). Social learning theory shows that teachers, by observing and imitating the innovative practices of colleagues, not only acquire new skills and knowledge but also enhance their self-efficacy, boosting their motivation and confidence, and driving them to apply innovative strategies in their daily teaching and leadership practices, thus fostering continuing development (Bandura, 1977, 1986).

Research Method

This study used exemplary high school teachers in Guangxi, China, as the sample. A total of 125 valid questionnaires were collected. Data collection took place from September to October 2024. A survey was conducted to obtain teachers' perceptions and evaluations of the relationship between PTL, TIL, and TCPD. The study aimed to reveal the direct and indirect effects of principal's leadership style on teachers continuing professional development. It also analyzed the mediating role of teacher innovative leadership.

The questionnaire used in this study was adapted from validated scales and adjusted to fit the Chinese educational context. The questionnaire consisted of two parts: A and B. Part A collected demographic information about respondents and their principals, including gender, age, education level, professional title, and years of teaching experience. Part B contained 69 questions. These questions measured three key dimensions: PTL, TIL, and TCPD. PTL was measured based on the scale by Li & Shi (2005). TIL referred to the framework proposed by Zhu et al. (2024). TCPD was measured based on the scale by Vries et al. (2013). Each question in the questionnaire used a seven-point scale (1 = strongly disagree, 7 = strongly agree). This captured teachers' genuine perceptions of principal leadership style, teacher innovative leadership, and professional development.

To ensure the face validity of the questionnaire, seven experts in the field of educational management were invited to review and evaluate it. Based on expert feedback, we adjusted some items. For example, in the dimension of moral modeling, redundant or overly similar items, such as "My principal is willing to sacrifice personal interests for the benefit of the school," were removed. Items like "My principal prioritizes the collective and others' interests above personal benefits" were retained. Refinement of descriptions of innovative leadership:

Items such as "I have the ambition to pursue change" and "I have the challenging spirit and courage to reinvent the routine" were revised. They were changed to "I have the ambition to pursue educational reform" and "I have a challenging spirit and the courage to reinvent teaching routines." In addition, based on the analysis of the item content validity index (I-CVI), some items that did not meet the recommended standards for Factor Loading values were deleted. To ensure construct validity, the study employed Exploratory Factor Analysis (EFA) using principal component extraction and Varimax rotation. The factor loadings for all retained items were greater than 0.50, indicating a high correlation between each item and its corresponding construct. Subsequently, Confirmatory Factor Analysis (CFA) was conducted to further confirm the construct validity of the questionnaire. This included convergent validity and discriminant validity, and ensured the model fit met the standards.

The data collection for this study was conducted from September to October 2024 in Guangxi. A total of 150 questionnaires were distributed, and 125 valid questionnaires were collected. The effective response rate was 83.3%. Before distributing the questionnaires, all participants were informed of the purpose of the study. They were assured that their responses would be kept strictly confidential. Participation was entirely voluntary, and informed consent was obtained from all participants. This study strictly adhered to academic ethical standards. Before data collection, the purpose of the study and the voluntary nature of participation were explained in detail to all participants. Their personal information was kept strictly confidential and used only for academic research purposes. This study was approved by the Ethics Committee of the affiliated institution.

Experimental Results and Discussion

A total of 125 valid questionnaires were collected. In terms of gender distribution, females accounted for 52% (65 people), while males accounted for 48% (60 people). Regarding age distribution, the majority of teachers were aged 30-39 (51 people), followed by those aged 25-30 (39 people). For educational qualifications, 62 teachers held a bachelor's degree, and 35 teachers had a college diploma. Most teachers held an intermediate professional title (71 people), followed by those with a junior title (33 people). The majority of teachers had 6-10 years of teaching experience, totaling 46 people. Additionally, teachers in private schools (66 people) slightly outnumbered those in public schools (59 people). The study results are presented in four parts. These include Cronbach's alpha coefficient, EFA, CFA, and reliability index values.

Exploratory Factor Analysis

Table 1

Total Number of Items at Each Stage of Questionnaire Construction

No.	Scale	Initial Number of Item	Item for Final Survey
1	PTL (Principal's Transformational Leadership)	24	21
2	TIL (Teachers' Innovative Leadership)	23	23
3	TCPD (Teacher Continuing Professional Development)	22	18
	Total	69	62

Before conducting statistical factor analysis on PTL, TIL, and TCPD, the data suitability was assessed. Some items were removed, as shown in Table 1. Seven items were deleted from the original 69 items, retaining 62 valid items. According to Table 2, the communalities for PTL, TIL, and TCPD indicate that 21, 23, and 18 items respectively exceeded the threshold of 0.5. This also means the sample size is acceptable (Hasim, Jabar, & Woo, 2024). The Kaiser-Meyer-Olkin values for PTL, TIL, and TCPD were 0.893, 0.891, and 0.899 respectively, exceeding the minimum value of 0.6 for good factor analysis (Lee & Ali Khan, 2024).On the other hand, Bartlett's test of sphericity showed a sufficient significance level of correlation among items at $p < .05$ (Niniel & Sucuahi, 2023).

Table 2
KMO and Bartlett's Test

Options		PTL	TIL	TCPD
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.893	.891	.899
Bartlett's Test of Sphericity	Approx. Chi-Square	2833.780	2564.801	2272.935
	df	276	253	231
	Sig.	.000	.000	.000

Table 3
Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
The Total Variance Explained of PTL (n=125)									
1	9.568	39.868	39.868	9.568	39.868	39.868	5.097	21.238	21.238
2	3.334	13.890	53.758	3.334	13.890	53.758	4.290	17.873	39.111
3	2.874	11.974	65.732	2.874	11.974	65.732	4.233	17.594	56.705
4	2.033	8.472	74.204	2.033	8.472	74.204	4.200	17.499	74.204
The Total Variance Explained of TIL (n=125)									
1	9.038	39.297	39.297	9.038	39.297	39.297	4.128	17.948	17.948
2	3.352	14.573	53.871	3.352	14.573	53.871	4.072	17.705	35.652
3	2.313	10.055	63.925	2.313	10.055	63.925	3.968	17.253	52.905
4	2.198	9.557	73.482	2.198	9.557	73.482	3.327	14.465	67.370
5	1.906	8.287	81.769	1.906	8.287	81.769	3.312	14.399	81.769
The Total Variance Explained of TCPD (n=145)									
1	8.081	36.730	36.730	8.081	36.730	36.730	5.018	22.809	22.809
2	3.881	17.639	54.369	3.881	17.639	54.369	4.955	22.567	45.377
3	2.821	12.823	67.192	2.821	12.823	67.192	4.799	21.815	67.192

Additionally, according to the data shown in Table 3, the total variance explained in the exploratory factor analysis of PTL, TIL, and TCPD provides an in-depth understanding of the data structure. For PTL, the four factors explained a cumulative variance of 74.204%, indicating a strong explanatory power for the PTL structure. For TIL, the five factors explained a cumulative variance of 81.769%, showing high explanatory power for TIL. In the case of

TCPD, the total variance explained was 67.192% of the cumulative variance. This indicates that the respective factors of PTL, TIL, and TCPD have high structural explanatory power, demonstrating good data fit. The rotated factor loadings show a more balanced explanation among the factors. This helps to avoid the concentration effect of a single factor's explanatory power, thereby enhancing the robustness of the model.

Confirmatory Factor Analysis

This experiment conducted a step-by-step analysis of the convergent and discriminant validity of each construct. The test of convergent validity shown in Table 4 indicates that the CR (Composite Reliability) and AVE (Average Variance Extracted) of all constructs met the standards proposed by Moses & Kim (2014). Specifically, CR values were greater than 0.7, and AVE values were greater than 0.5.This indicates that the items of each construct have high consistency in measurement and can explain most of the variance. For example, the CR value of CLAT was 0.952, and the AVE was 0.766. This means that the items effectively reflect the latent characteristics of the construct. In addition, the CR value of MRMD was as high as 0.962, and the AVE was 0.809, further proving strong consistency in its measurement. These results indicate that the measurement model of this study performs well in terms of reliability and validity (Sideridis, Tsaousis, & Al-Sadaawi, 2019).

Table 4
Convergent Validity and Composite Reliability

Construct	Item	Loading	CR	AVE
CLAT	CLAT01	0.869	0.952	0.766
	CLAT02	0.86		
	CLAT03	0.896		
	CLAT04	0.842		
	CLAT05	0.908		
	CLAT06	0.876		
EMII	EMII01	0.867	0.931	0.772
	EMII02	0.907		
	EMII03	0.866		
	EMII04	0.873		
HWTI	HWTI01	0.849	0.931	0.73
	HWTI02	0.841		
	HWTI03	0.87		
	HWTI04	0.849		
	HWTI05	0.863		
IDCS	IDCS01	0.884	0.95	0.793
	IDCS02	0.878		
	IDCS03	0.917		
	IDCS04	0.885		
	IDCS05	0.889		
IMII	IMII01	0.881	0.928	0.764
	IMII02	0.839		
	IMII03	0.873		
	IMII04	0.903		

LDCM	LDCM01	0.882	0.947	0.783
	LDCM02	0.871		
	LDCM03	0.893		
	LDCM04	0.918		
	LDCM05	0.859		
MRMD	MRMD01	0.877	0.962	0.809
	MRMD02	0.882		
	MRMD03	0.914		
	MRMD04	0.918		
	MRMD05	0.894		
	MRMD06	0.912		
RFAT	RFAT01	0.873	0.955	0.78
	RFAT02	0.89		
	RFAT03	0.857		
	RFAT04	0.893		
	RFAT05	0.896		
	RFAT06	0.889		
TDPR	TDPR01	0.916	0.941	0.763
	TDPR02	0.875		
	TDPR03	0.87		
	TDPR04	0.84		
	TDPR05	0.864		
TKCT	TKCT01	0.85	0.943	0.769
	TKCT02	0.904		
	TKCT03	0.897		
	TKCT04	0.865		
	TKCT05	0.866		
UDAT	UDAT01	0.871	0.948	0.751
	UDAT02	0.832		
	UDAT03	0.909		
	UDAT04	0.896		
	UDAT05	0.859		
	UDAT06	0.83		
VSIP	VSIP01	0.897	0.95	0.791
	VSIP02	0.868		
	VSIP03	0.878		
	VSIP04	0.894		
	VSIP05	0.91		

In the test of discriminant validity, Table 5 presents the correlation matrix between the constructs. The values on the diagonal represent the square root of the AVE of each construct. According to the criterion proposed by Fornell and Larcker (1981), the square root of the AVE of each construct should be greater than its correlation with any other construct (Gomez, Vance, & Stavropoulos, 2018).The results show that, for example, the correlation coefficient between MRMD and VSIP is 0.491. This is lower than the square root of their respective AVEs

(MRMD is 0.899, VSIP is 0.889). This indicates good discriminant validity between these two constructs. Similarly, the correlation coefficient between IDCS and TKCT is 0.061, showing significant statistical independence between these two constructs. In addition, the correlation coefficient between IMII and EMII is 0.314, which is also lower than their respective AVE square roots. This further supports the discriminant validity of the model.

Table 5
Discriminant Validity

	MRMD	VSIP	LDCM	IDCS	TKCT	HWTI	TDPR	EMII	IMII	UDAT	RFAT	CLAT
MRMD	0.899											
VSIP	0.491	0.889										
LDCM	0.382	0.384	0.885									
IDCS	0.293	0.478	0.324	0.891								
TKCT	0.379	0.478	0.179	0.061	0.877							
HWTI	0.231	0.226	0.293	0.157	0.295	0.855						
TDPR	0.379	0.436	0.287	0.256	0.486	0.34	0.875					
EMII	0.435	0.397	0.331	0.203	0.382	0.407	0.417	0.889				
IMII	0.266	0.305	0.36	0.292	0.309	0.469	0.342	0.314	0.883			
UDAT	0.169	0.359	0.294	0.509	0.16	0.336	0.306	0.263	0.44	0.847		
RFAT	0.376	0.323	0.287	0.258	0.324	0.226	0.361	0.304	0.414	0.383	0.883	
CLAT	0.385	0.317	0.259	0.067	0.457	0.397	0.482	0.454	0.313	0.222	0.394	0.876

These results indicate that the constructs in this study have high reliability and validity in measurement. The constructs also exhibit good discriminant validity. By meeting the Fornell-Larcker criteria and reliability indicators, these results lay a solid foundation for subsequent structural equation modeling analysis. This finding is consistent with the requirements of measurement models in the existing literature (Ab Hamid, Sami, & Mohmad Sidek, 2017).

Reliability Index

Table 6

All items selected in the final survey, their initial constructs, factor loadings, and Cronbach's Alpha

Selected Items of TIL for Final Survey, Its Initial Construct, Factor Loading and Cronbach's Alpha					
Construct	Item Code	Item	Factor Loading	Cronbach's Alpha	Cronbach's Alpha
TKCT	TKCT02	I am good at drawing on experiences from teaching practice to generate new ideas.	.884	.943	.929
	TKCT05	I am able to think from many different angles.	.866		
	TKCT01	I am capable of proposing unique or novel ideas.	.865		
	TKCT03	I am able to think ahead, to predict the potential change and development of work.	.849		
	TKCT04	I can approach questions creatively and present innovative ideas and solutions.	.847		
TDPR	TDPR05	I can tolerate mistakes and failures in the process of teaching innovation.	.864	.941	
	TDPR03	I encourage colleagues to do the work according to their own views and ways of doing things.	.863		
	TDPR01	I am open and inclusive, listening to suggestions from multiple sources.	.858		
	TDPR02	I am receptive to opinions different from my own.	.856		
	TDPR04	I can tolerate the potential risks that come with teaching innovation.	.815		
HWTI	HWTI01	I have the ambition to pursue educational reform.	.863	.930	
	HWTI03	I can be unconventional and seek distinctive teaching concepts or methods.	.855		
	HWTI05	I make every effort to ensure the realization of teaching innovation.	.848		
	HWTI04	I believe so firmly in the value of teaching innovation that I dare to face questioning.	.833		
	HWTI02	I have a challenging spirit and the courage to reinvent teaching routines.	.823		
IMII	IMII04	I actively try to transform innovative ideas into practical usage.	.881	.927	
	IMII01	I make feasible educational plans to implement innovative ideas.	.868		

	IMII02	I regularly evaluate the implementation progress of the innovative teaching ideas.	.855		
	IMII03	I actively communicate with colleagues and school management to gain their support for implementing innovative ideas.	.854		
EMII	EMII02	I provide colleagues with opportunities to learn new knowledge and explore new things.	.901	.930	
	EMII03	I establish platforms for colleagues to communicate and discuss.	.862		
	EMII04	I expand/develop various mechanisms and channels to obtain creative teaching ideas.	.861		
	EMII01	I organize professional exchange activities to share new ideas and practices.	.815		
Selected Items of PTL for Final Survey, Its Initial Construct, Factor Loading and Cronbach's Alpha					
RMD	MRMD04	My principal prioritizes the collective and others' interests above personal benefits.	.902	.962	
	MRMD01	My principal is honest and selfless, not seeking personal gain.	.895		
	MRMD03	My principal works with dedication without concern for personal gain or loss.	.883		
	MRMD06	My principal shares in both the difficulties and successes with the teachers.	.867		
	MRMD05	My principal does not claim others' achievements as their own.	.867		
	MRMD02	My principal endures hardships first and enjoys benefits last.	.861		
IDCS	IDCS05	My principal is concerned with the growth and development of the teachers.	.905	.947	.937
	IDCS03	My principal frequently shows concern for the work, life, and family situations of teachers.	.903		
	IDCS06	My principal creates opportunities for teachers to showcase their talents.	.884		
	IDCS01	My principal considers the personal circumstances of teachers during interactions.	.866		
	IDCS02	My principal is willing to help teachers with difficulties in their personal or family lives.	.829		
LDCM	LDCM04	My principal is deeply engaged in their work, consistently maintaining high enthusiasm.	.900	.950	

	LDCM03	My principal loves their work and has a strong sense of career ambition.	.888		
	LDCM06	My principal is adept at handling difficult situations.	.869		
	LDCM02	My principal is open-minded and possesses a strong sense of innovation.	.865		
	LDCM01	My principal has strong professional abilities.	.864		
VSIP	VISP04	My principal paints a compelling picture of the future for everyone.	.872	.949	
	VISP05	My principal provides teachers with clear goals and directions for their efforts.	.871		
	VISP03	My principal explains the long-term significance of the work being done.	.849		
	VISP01	My principal helps teachers understand the school's future prospects.	.847		
	VISP02	My principal clearly communicates the school's development philosophy and goals to the teachers.	.802		
Selected Items of TCPD for Final Survey, Its Initial Construct, Factor Loading and Cronbach's Alpha					
RFAT	RFAT05	I study products from students to understand how my approach has worked.	.894	.947	.925
	RFAT04	I ask my colleagues to attend some of my lessons to get feedback on my teaching.	.880		
	RFAT01	After class, I reflect on my lessons.	.872		
	RFAT02	I discuss my students' experiences in my classes with them to improve my teaching practice.	.870		
	RFAT06	I use student performance data to, where needed, adjust my teaching.	.867		
	RFAT03	I observe my colleagues' lessons to learn from them.	.845		
CLAT	CLAT04	I discuss improvements and innovation in education at my school with colleagues.	.900	.951	
	CLAT03	I share new teaching ideas with my colleagues.	.888		
	CLAT07	I study student performance data with colleagues.	.885		
	CLAT09	I experiment with new teaching methods with colleagues.	.884		
	CLAT01	I talk about teaching problems with colleagues.	.873		
	CLAT05	I develop new curricula with my colleagues.	.839		

UDAT	UDAT03	I read professional journals or academic literature.	.898	.955
	UDAT04	I visit digital communities related to my subject area.	.888	
	UDAT01	I read the latest educational materials.	.888	
	UDAT05	I participate in professional development activities inside and outside of school (e.g., courses, workshops, training sessions, conferences, summer courses, online).	.866	
	UDAT02	I read materials related to educational reform and educational practices (e.g., through newspapers, television, the internet).	.856	
	UDAT06	I visit conferences and meetings pertaining to my subject matter or hosted by my professional association.	.836	

The reliability test of this study was based on questionnaire survey data, analyzed using SPSS software. Cronbach's Alpha coefficient was used in reliability analysis to evaluate the internal consistency of each construct. According to Wigley (2011), questionnaires with Cronbach's Alpha values between 0.80 and 0.95 have high reliability. Questionnaires with values between 0.65 and 0.79 are also considered acceptable measurement tools. Mosmuller et al. (2016) also pointed out that items with Cronbach's Alpha values between 0.61 and 1.00 have good dependability. Furthermore, Popa (2020) suggested that Cronbach's Alpha should reach or exceed 0.70. The closer it is to 1, the higher the reliability of the scale. Therefore, to ensure the quality and consistency of the questionnaire data, this study adopted rigorous reliability analysis standards.

Table 6 shows the reliability analysis results of the final questionnaire. The TKCT construct contains five items, with a Cronbach's Alpha value of 0.943. This indicates high consistency in evaluating teachers' innovative thinking abilities. The Cronbach's Alpha coefficient for the TDPR construct is 0.941, reflecting stability in measuring teachers' openness to diverse opinions. The Alpha value for the HWTI construct is 0.930, further demonstrating measurement reliability in teachers' pursuit of educational innovation. The reliability coefficient for the IMII construct is 0.927, indicating consistency in measuring teachers' ability to turn innovative ideas into practical applications. The reliability analysis result of EMII also reached 0.930, showing reliability in evaluating innovative interactions among teachers.

In the principal leadership constructs, the MRMD construct has a Cronbach's Alpha value of 0.962. This indicates extremely high internal consistency in measuring principals' moral behavior and dedication. The Alpha value for the IDCS construct is 0.947, indicating high reliability in evaluating principals' support for individual teacher development. The reliability coefficient for the LDCM construct is 0.950, proving the consistency of the measurement tool for principals' work engagement and professional motivation. The Alpha value for the VSIP

construct is 0.949, showing stability in measuring principals' vision-setting for the school and motivating teachers.

In the construct of Teachers' Continuing Professional Development, the Alpha value of RFAT was 0.947. This indicates a high level of consistency in measuring teachers' reflective and feedback-driven teaching practices. The reliability of CLAT was 0.951, indicating stability in measuring teachers' collaborative learning and teaching. The Alpha coefficient of the UDAT construct reached 0.955, further proving the high consistency in measuring teachers' participation in professional development activities.

In summary, the Cronbach's Alpha coefficient for all constructs in this study exceeded 0.9. This indicates that the questionnaire has very high reliability, meeting the reliability standards proposed by Hair, Hult, Ringle, and Sarstedt (2021). This shows that the questionnaire can accurately capture the core characteristics of each construct, laying a solid foundation for subsequent structural equation modeling analysis. Based on these analysis results, it can be concluded that the measurement tool used in this study has high reliability in practice. It can also provide valuable data support for research in the field of education.

Conclusion

This study marks the initial exploration and practice by the researchers before moving to the formal research stage. The implementation of this study clarified a set of conditions that must be met to ensure high validity and reliability of future research results. It laid a solid foundation for subsequent formal research. The determination of the measurement scale paves the way for the formal study, which will further reveal how PTL and TIL work together to influence TCPD, promote teachers' professional growth, and contribute to the overall development of the school.

Contribution

This study makes significant contributions both theoretically and contextually. Theoretically, it expands the existing body of knowledge by exploring in depth the interrelationship between Principal's Transformational Leadership (PTL) and Teachers' Innovative Leadership (TIL), as well as their joint impact on Teacher Continuing Professional Development (TCPD), addressing the limitations of previous research that examined these constructs separately. The study provides a more detailed understanding of how school leadership influences teaching practices and professional growth. Contextually, the findings offer practical insights for educational leaders, helping them create environments that promote teacher development and innovation. Especially in the context of educational reform and the challenges schools face, the study offers a framework for integrating leadership and professional development strategies to achieve sustainable improvements. Thus, this research not only advances academic discussions but also provides actionable recommendations for educational practice.

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