

RESEARCH ARTICLE

A study on the impact of perceived leadership member exchange on innovation behavior by university lectures

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ABSTRACT

Based on the social exchange theory, this study used the convenience maximization method to submit a form to 832 teachers. SPSS and AMOS software were used to analyze teachers' cognition of leader-member exchange (LMX) and teachers' psychological empowerment and psychological safety in innovative behavior. Meanwhile, the influence of education and professional background on these factors was evaluated. It also explores the impact of the quality of leader-member exchange on innovation, and the intrinsic role of psychological empowerment and psychological safety in the process. The results show that teachers with different academic levels and titles have significant differences in leader-member interaction behavior, behavioral innovation, psychological empowerment and psychological safety. In addition, the quality of leader-teacher interaction is positively correlated with innovative behavior and psychological empowerment, indicating that leadership plays a positive role in improving teachers' innovative behavior. Psychological empowerment and psychological safety, as the key, connect the complex relationship between leadership, educational environment and innovative behavior.

These findings not only provide practical strategies for higher education administrators to promote teacher innovation, but also provide a theoretical basis for widespread application in the field of organizational and environmental psychology, highlighting the potential role of leadership in creating environments that support innovation, empowerment, and safety. This framework provides a powerful tool for creating an innovative and conducive work environment. Supported.

Keywords: Leading member exchange (LMX); innovative behavior; psychological empowerment; psychological safety

1. Introduction

In the era of knowledge economy, innovation and flexibility are not only the cornerstone of social survival and development, but also the key drivers of national competitiveness. Education, as the core field of knowledge inheritance and innovation, is of great importance. University is not only an important foundation for training high-quality talents, but also a frontier for knowledge exchange, ideological collision and innovative practice ^[1]. Effective training of college teachers' innovative behavior is not only the key to improve the quality of education, but also has a crucial impact on the country's overall innovation ability and long-term development.

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However, teachers' innovative behavior is not naturally occurring, but is influenced by explosive factors, in which the quality of communication between leaders and members (leadership exchange members, LMX) is extremely important. The LMX theory emphasizes that the relationship between high-quality leadership members based on mutual respect, trust and contribution can stimulate the inherent potential of teachers, go beyond traditional roles, and exhibit more innovative behaviors [2,3]. In addition, the psychological state of teachers, especially psychological empowerment and psychological safety, has a significant intrinsic role in LMX and innovative behavior. Psychological empowerment enhances teachers' self-awareness and enables them to be endowed with trust and support, thus stimulating the inherent motivation for innovation [4]. The establishment of psychological security provides a necessary environment for innovative behavior, enabling teachers to challenge traditional concepts and promote educational innovation [5].

This study focuses on the role of psychological environment in stimulating innovation, based on the environmental and social psychological framework in which LMX has a greater impact on teachers' innovative behavior. Specifically, the study analyzes how the interaction between leaders and members affects teachers' psychological empowerment and sense of security, and reveals the key role of these psychological factors in forging innovation behavior. These results not only enrich the theoretical research of educational management, but also provide college administrators with the support of creating innovative social and psychological environment. This perspective of integrated social psychology helps to understand more comprehensively how to optimize the interpersonal interaction in the educational environment, promote teacher innovation, take the lead in improving the quality of education, and promote social progress.

2. Literature review and hypothesis construction

2.1. The effect of the quality of leader-member exchange in education on teachers' innovativeness

The leader-member exchange (LMX) theory draws from social exchange theory and incorporates perspectives from scholars such as Blau, Hollander, and Julian. Central to LMX is its exploration of the dynamic interaction process between leaders and members, highlighting the significance of interdependence and influence [6]. LMX theory specifically describes the close leader-subordinate relationship built through respect, loyalty and mutual contribution, which has been proved by many studies to be closely related to innovative behavior [7]. Further, studies show that high-quality LMX not only promotes the improvement of individual innovation ability, but also significantly enhances the innovation performance of the whole team [8]. In the realm of education, robust leader-member relationships have been empirically shown to positively influence the stimulation of teachers' innovative behavior. This fully demonstrates the practical effectiveness of LMX theory in promoting organizational innovation and enhancing value creation [9].

The quality of leader-member exchange (LMX) in the field of education has been widely confirmed as a key factor affecting teachers' ability to innovate, which highlights the indispensability of building high-quality LMX relationships in driving teachers' innovative activities. Drawing from the theoretical underpinnings of self-determination theory, this study endeavors to enhance teachers' intrinsic motivation and foster their innovative behavior through an exploration of strategies aimed at fulfilling their fundamental psychological needs, especially to enhance their sense of psychological empowerment and security. It further points out that building trust, optimizing communication channels and strengthening mutual respect between principals and teachers can create a supportive environment to promote teachers' innovative behavior. In summary, hypothesis.

H1: Leadership member exchange is a significant positive predictor of teacher innovation behavior.

2.2. Psychological empowerment: a key mediator between leadership-member exchange and innovative behaviour

In academic research, Psychological authorization is widely adopted to explore the different leadership styles and all kinds of work related to employee attitudes (concrete cover teacher innovation behavior and organizational commitment, etc.) the core of the relationship between the intermediary or adjusting variables^[10]. Dulebohn and his research team pointed out through empirical research that there is a significant and profound relationship between the quality of leader-member exchange (LMX) and followers' perception of psychological empowerment, highlighting a notable association in their research. This discovery underscores psychological empowerment as a pivotal internal mechanism that robustly connects positive leader-member interactions with teachers' innovative behaviors^[11]. Given that leaders have the ability to shape members' autonomy, enhance their discretion, and cultivate their perception of empowerment, it is expected that these key empowerment practices can stimulate the spirit of exploration and innovative behavior in teacher groups.

Recently, the research results of Almulhim (2020) and Khan et al. (2022) further deepened this field. Through empirical analysis, they pointed out that leader-member exchange (LMX) relationship mediated by psychological empowerment. Indirectly promote the staff's initiative innovation behavior^[12]. Specifically, high-quality leader-member relationship can enhance individuals' sense of psychological empowerment, which in turn acts as a catalyst for strengthening the relationship between core self-evaluation and LMX, further stimulating employees' initiative and innovation. The complex interaction effects observed in this study significantly reveal the crucial role of psychological empowerment in fine-tuning the association between leader-member exchange (LMX) and employee positive innovation behavior, underscoring its academic stature as a pivotal intermediary factor. Drawing upon a comprehensive theoretical framework and robust empirical findings, this study posits hypotheses to further elucidate these dynamics.

H2: Psychological empowerment is hypothesised to be a key mediator between the leader-member exchange relationship and their innovative behaviours among university teachers in Xi'an.

2.3. Psychological safety: a mediating perspective on leader-member exchange for innovative behaviour

Research indicates that high-quality leader-member exchange fosters an environment conducive to enhancing employees' psychological security, thereby mediating the promotion of innovative behavior^[13]. Psychological security enhancements to promote the participation of more positive interaction between team members, create a positive atmosphere for innovation behavior^[14]. Edmondson emphasized that a safe environment stimulates the motivation for innovation, while Kark and Carmeli confirmed that psychological security promotes creativity and improves innovative behavior. In conclusion, Improve the quality of interactions between leaders and members and bolstering employees' psychological security proves instrumental in fostering team innovation vitality.

Edmondson conceptualizes psychological security as a foundational state characterized through mutual respect and mutual trust, this state of mind is unique in that it carefully creates an environment in which employees can face and take interpersonal risks and challenges without fear. In such settings, heightened psychological safety correlates with increased readiness to embrace challenges and significantly diminishes apprehension over potential failure consequences^[15], and actively contribute innovative thinking. These employees feel comfortable and comfortable in expressing their personal opinions, and are willing to put forward constructive suggestions and original viewpoints, thus effectively promoting the innovation process of the organization. On the contrary, People of low psychological quality security tend to show obvious

defensive posture and insecurity when participating in high-risk innovation work, which may constitute a certain obstacle to their innovation contribution^[16]. Therefore, this study proposed research hypothesis.

H3: Psychological safety factors play an important role as a mediating bridge between the leader-member exchange relationship and innovative behaviours of teachers in Xi'an university.

3. Methodology

3.1. Research system

Based on the dual perspectives of Social Exchange Theory and Deci and Ryan's Self-Determination Theory (SDT), this study focuses on the Xi'an University faculty group and provides insights into how the Leader-Member Exchange (LMX) mechanism effectively acts on and promotes faculty's innovative behaviours. Through this comprehensive theoretical framework, this study seeks to reveal the critical role of LMX in stimulating teachers' innovative potential and shaping a positive work environment.

Employing a meticulously crafted mediation research framework (**Figure 1**).

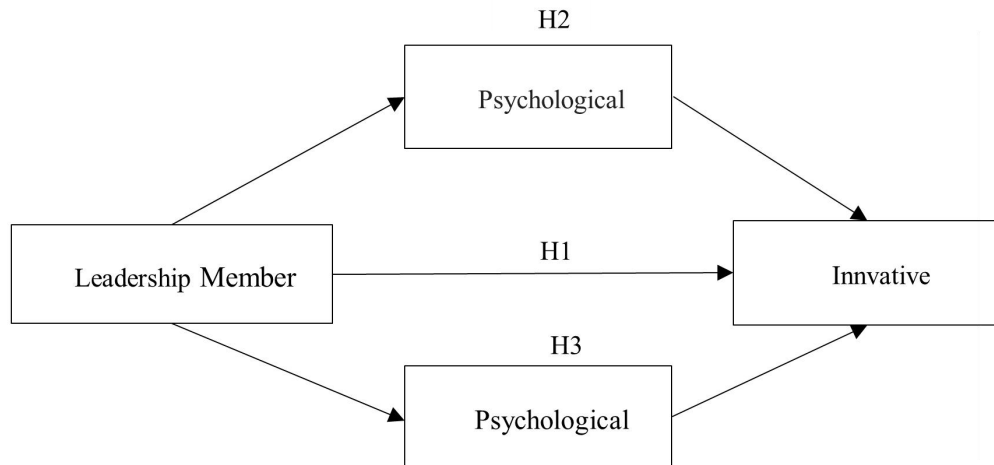


Figure 1. Research framework. LMX: Leader-Member Exchange; IB: Innovative Behaviour; PE: Psychological Empowerment; PS: Psychological Safety (same as below, not labelled).

3.2. Research object

Due to the problems of time and funds, this study only selected teachers from three universities in Xi 'an as the research objects. Sudeman convenient sampling method was adopted to set a sample size of 700-900 people. 845 questionnaires were successfully collected through online questionnaire method, with a response rate of 99.4%, which ensured the reliability of the study. It is worth noting that the context-specific and environmental work of this population provides us with a representative data source. This method may not be fully representative of college teachers across the country, but its application in specific regions and groups still has improved effects and research value. Future studies can further validate these findings with other sampling methods, but this does not mean that the conclusions of this study have lost their broad applicability. Instead, this study lays a solid foundation for future exploration in different regions and in a broader sample.

3.3. Measurement

In the current research endeavor, the LMX-MDM Multidimensional Questionnaire, a refined and enhanced version of the seminal Liden and Maslyn^[17] scale, which underwent revision by Wang et al.^[18], was employed as the cornerstone instrument for evaluating the intricate dynamics of leader-member

exchange relationships. This version of the questionnaire retains the 12 core items of the original questionnaire and incorporates 4 new items, which together build a richer and more multidimensional assessment framework. By using a five-point Likert scale for scoring, the questionnaire is able to achieve in-depth and comprehensive quantitative analyses of the quality of the relationship between leaders and members. It is worth noting that the Cronbach Alpha coefficient of the questionnaire is as high as 0.903 after a rigorous reliability test, which fully proves its high level of internal consistency and reliability.

In this research endeavor, the innovative behavior scale was meticulously crafted by harmoniously amalgamating the groundbreaking evaluation methodologies devised by De Jong and Den Hartog in 2008, alongside the contributions made by Messmann and Mulder in 2012, thereby offering a comprehensive framework for assessing innovative behaviors, and made targeted adjustments and optimization on this basis. To ensure that it can accurately reflect and adapt to the actual situation in the specific research background. The scale was scored using a standardized 5-point Likert scale, and after rigorous data analysis, its Cronbach Alpha was as high as 0.926.

This study uses the Psychological Empowerment Scale developed by Spreitzer in 1995, which includes four dimensions of meaning, ability, self-determination and influence. Cronbach Alpha value was 0.872, which was measured by 5-point Likert scale with high reliability.

Ultimately, the Psychological Security Scale was selected from the Security Questionnaire (SQ) jointly developed by Cong Zhong and An Lijuan, which is designed to provide an in-depth assessment of an individual's sense of interpersonal security as well as the two dimensions of certainty/control. This scale endeavors to delve into the intricate nuances of two pivotal dimensions: the individual's sense of interpersonal security and their perception of certainty/control, offering a profound understanding of these critical psychological constructs. The scale was scored according to the rigorous 5-point Likert scale format, and the Cronbach Alpha value was as high as 0.933 through statistical verification.

3.4. Data analysis

In a meticulous and methodical fashion, the research endeavor harnessed the advanced capabilities of SPSS 23.0 and AMOS 24.0 software to delve into the amassed data, ensuring a thorough examination. Additionally, each questionnaire underwent a stringent gauntlet of internal coherence evaluations and validity scrutinization, reinforcing the rigor and integrity of the analytical process.

4. Analysis of results

4.1. Data description and reliability analysis

This research endeavor involves a comprehensive analysis of the titles and demographic profiles of 832 university educators in Xi'an, utilizing the advanced capabilities of SPSS and AMOS software. The exhaustive findings of this analysis are meticulously presented in **Table 1**.

Table 1. Reliability analysis of the LMX, IB, PE, and PS scales.

Construction	Full Krumbach Alpha
LMX(A)	.922
IB(B)	.907
PE(C)	.902
PS(D)	.928

Dimensions	Krumbach's alpha
Feelings(A1)	.879
Loyalty(A2)	.856
Contribution(A3)	.868
Professional respect(A4)	.874
Opportunities to identify/explore(B1)	.879
When good ideas arise(B2)	.883
Promoting ideas(B3)	.891
Ideas for realization(B4)	.907
ability(C1)	.846
Right to self-determination(C2)	.837
Impact(C3)	.849
Meaning(C4)	.847
Interpersonal safety(D1)	.918
The certainty of safety(D2)	.909

¹Table 1. (*Continued*).

The present research concentrates on the cohort of higher education instructors residing in Xi'an city, employing the leader-member exchange scale and its multidimensional framework to undertake rigorous reliability assessments. The objective is to evaluate the scale's efficacy in measuring the internal coherence of college teachers' perceptions and behaviors. Cronbach Alpha coefficient was used as the core index for reliability analysis, in which a coefficient higher than 0.7 was generally regarded as the standard for good reliability. The results showed that regardless of the leader-member communication scores (Cronbach Alpha coefficient:0.922), teacher innovation behavior(0.907), psychological authorization (0.902) or psychological safety (0.928), all showed very high Cronbach Alpha coefficient values, far exceeding the threshold of good reliability. This series of data strongly confirms that the scales used not only have strong reliability, but also show a high degree of reliability and representativeness in terms of the factors and constructs they cover.

4.2. Analysis of exploratory factors

To prevent potential confounding effects^[17]. In the course of this investigation, the development and execution of four distinct questionnaires—the Leader-Member Exchange Questionnaire, the Teacher Innovative Behaviour Questionnaire, the Psychological Empowerment Questionnaire, and the Psychological Safety Questionnaire—were carried out concurrently. Dami et al. posit that a substantial common method bias emerges prominently when a solitary factor accounts for more than half of the total variability, thereby significantly influencing the outcomes. In response to this, the current study embraced the unidirectional test introduced by Harman (1960) as a means to execute an exhaustive exploratory factor analysis on the entirety of the gathered questionnaire items. This approach aimed at uncovering and subsequently mitigating any potential methodological biases that may have arisen.

For the purpose of this investigation, the KMO test and Bartlett's test of sphericity were employed as a dual approach to meticulously evaluate the appropriateness of the questionnaire data for undergoing factor analysis methodologies. KMO value >0.8 is considered robust, 0.7-0.8 is moderate, 0.6-0.7 is acceptable, and <0.5 is not suitable. Bartlett sphericity test p values <1% ensure applicability of factor analysis. Two factor analysis feasibility of test validate questionnaire data together.

The KMO value of psychological empowerment scale reached 0.893, significantly higher than the 0.7 threshold proposed by Kaiser(1974), which proved the validity of data extraction in factor analysis. All four factors had a narrow range of explanatory power, from 19.06% to 19.36%, which gave the cumulative variance after rotation an impressive 76.66%. This figure exceeds the customary benchmark of 40%, highlighting the robustness of the element structure. In addition, the eigenvalues for all factors significantly exceeded the uniform threshold, and the Bartlett sphericity test produced a striking value of 5274.905 (df=66, $p<0.001$), convincingly meeting the criteria for statistical significance.

The KMO value of the psychological safety scale is as high as 0.961, far exceeding the 0.7 threshold, which proves that the data extraction is successful. The contribution rates of these two main factors to the variance interpretation of the scale data were 32.09% and 30.59% respectively. After factor rotation, the cumulative variance reached 62.68%, far exceeding the accepted standard of 40%. All eigenvalues significantly exceed the limit value of 1, and the Bartlett test for sphericity value is 5274.905,df=66, $p<0.001$, which is very significantly consistent with the standard.

4.3. Validation factor analysis

The core purpose of this study is to explore in depth the intricate interplay and correlation between leader-member exchange dynamics, teacher innovation practices, intrinsic psychological empowerment, and emotional security. The structural equation modeling technique is used to systematically test the causal relationship among the key variables, and the goodness of fit of the constructed model is evaluated. Initially, the study began a rigorous evaluation process using confirmatory factor Analysis (CFA) as its underlying evaluation tool. AMOS software was used to test the scale, the reliability of the scale was reviewed, and the overall validity and discriminant validity of the scale were discussed, so as to ensure that the quality of the data met the highest scientific standards. Among them, the composite reliability (CR) index exceeds the threshold value of 0.6, which verifies that the variable is highly consistent with its underlying structure. The AVE(mean Variance Extraction) index exceeds the critical threshold of 0.5, providing strong proof of the scale's impeccable convergent validity and excellent discriminant power. Then, on the basis of the results of the first stage, a simplified index set is selected to enter the structural modeling stage to further explore the complex relationship between variables.

In this study, confirmatory factor analysis was used to evaluate and verify the four scales in depth. The study of the data shows that the factor contributions of all considered items (all above the threshold of 0.5), the extracted mean variance (AVE values above the 0.5 standard), and the combined reliability (CR values consistently above the 0.8 optimal level) fully meet the established criteria, indicating good convergence validity. Model fitting evaluation showed that $\chi^2/df(<5)$, RFI(>0.9), GFI(>0.9), NFI(>0.9) and other key indicators met the high standard, which proved that the model fit was good and the structural validity was strong. The scale has high fit and structure validity.

The purpose of this study was to verify the aggregate validity of the scale and evaluate the fit of the model by statistical analysis. This research delves into scrutinizing the factor loadings of the variable, setting a stringent criterion of exceeding 0.5. Additionally, it mandates a composite reliability (CR) threshold surpassing 0.6 and a mean variance extraction (AVE) value above 0.5, both serving as formidable indicators of the scale's robust convergence validity. Strict criteria were set for the evaluation of model fit, including that the χ^2/df ratio should be less than 5, that RFI, GFI, NFI, and all incremental fit metrics stipulated ought to exceed 0.9, with RMSEA strictly remaining beneath 0.08. The confirmatory factor analysis conducted on the variables outlined in Table 4-2, It covers the interactive exchange between leaders and members, the innovative behavior of teachers, the inner psychological empowerment and the psychological security of

individuals. Each variable, across all dimensions, has generated statistically significant coefficient estimates ($p < 0.05$), showcasing a robust performance. Notably, the factor load values exhibit a range of excellence, varying from 0.703 to 0.860, further substantiating the strength and validity of the underlying constructs. This finding not only revealed the strong correlation among the factors, but also confirmed once again that the scale and model construction of this study were in line with established academic standards and requirements.

Table 2. Confirmatory factor analysis.

Construction	d	p	Factor load (min/max)
LMX (A)	Feelings(A1)	0.000	0.754/0.826
	Loyalty(A2)	0.000	0.744/0.824
	Contribution(A3)	0.000	0.739/0.837
	Professional respect(A4)	0.000	0.746/0.832
	Opportunities to identify/explore(B1)	0.000	0.717/0.820
IB(B)	When good ideas arise(B2)	0.000	0.720/0.800
	Promoting ideas(B3)	0.000	0.703/0.812
	Ideas for realization(B4)	0.000	0.737/0.839
PE(C)	ability(C1)	0.000	0.760/0.805
	Right to self-determination(C2)	0.000	0.738/0.819
	Impact(C3)	0.000	0.763/0.844
	Meaning(C4)	0.000	0.766/0.827
PS(D)	Interpersonal safety(D1)	0.000	0.733/0.856
	The certainty of safety(D2)	0.000	0.720/0.860

Construction	d	AVE	CR
LMX (A)	Feelings(A1)	0.647	0.880
	Loyalty(A2)	0.603	0.858
	Contribution(A3)	0.627	0.871
	Professional respect(A4)	0.638	0.877
	Opportunities to identify/explore(B1)	0.596	0.881
IB(B)	When good ideas arise(B2)	0.604	0.884
	Promoting ideas(B3)	0.621	0.891
	Ideas for realization(B4)	0.665	0.909
PE(C)	ability(C1)	0.652	0.849
	Right to self-determination(C2)	0.638	0.841
	Impact(C3)	0.659	0.853
	Meaning(C4)	0.654	0.850
PS(D)	Interpersonal safety(D1)	0.586	0.918
	The certainty of safety(D2)	0.560	0.910

4.4. Correlation analysis

This research delves profoundly into the intricate interrelationships existing between the four pivotal dimensions: The interactive relationship between leaders and members, the creative practice of teachers, the feeling of empowerment at the psychological level and the sense of inner security. **Table 4-3** meticulously

documents the comprehensive Pearson correlation values among these dimensions, offering a detailed portrait of their interconnectedness.

Table 3. Summary of pearsonrelated studies of LMX, IB, PE and PS volume.

Construction	IB(B)	PE(C)	PS(D)	LMX (A)
means	3.368	3.255	3.175	3.240
deviation	.796	.877	.826	.839
IB	1	.525 * * *	.527 * * *	.579 * * *
PE		1	.490 * * *	.499 * * *
PS			1	.495 * * *
LMX				1

The current study harnesses the Pearson correlation coefficient as a powerful tool to delve into the intricate associations embedded within the data presented in Table 4-4. The aim is to explore the internal connection of the innovative behavior of the teachers, psychological authorization, psychological security and leadership-member exchange relationship. The analysis shows that there is a significant and positive correlation between teachers' innovative behaviour and psychological empowerment ($r=.525$), psychological safety ($r=.527$) and leader-member exchange ($r=.579$), which validate the positive impact of the three on teacher innovation behavior. In addition, leader-member exchange was not only significantly positively correlated with the individual's sense of psychological authorization ($r=.499$), but also closely related to its psychological safety level ($r=.495$), which further revealed the close relationship between positive interaction within organizations and individual psychological states.

4.5. Structural Equation modeling

Preliminary data validation (i.e., confirmatory factor analysis) revealed a significant correlation between observed variables, which provided a clear direction and basis for subsequent construction and verification of structural models.

This study conducted an in-depth analysis focusing on model fit analysis in the four core areas of leader-member exchange, teacher innovative behaviour, psychological empowerment and psychological safety. The process strictly adhered to the model validation criteria proposed by Marsh et al. (1988). This paper examines four core elements: communication between leaders and members, innovative initiatives by teachers, a sense of empowerment on a psychological level, and an individual's psychological security. The rigorous evaluation criteria for model fitting were precisely defined, necessitating that CMIN/DF be less than 3, with NFI, IFI, and CFI exceeding 0.9, TLI greater than 0.8, GFI above 0.8, and RMSEA remaining below 0.08. These metrics were adopted to safeguard the robust convergence validity of the scale and to ensure that all incremental fitting indices surpassed a high threshold of 0.90. Consequently, a meticulous model fitting analysis was conducted, focusing on the aforementioned four dimensions. The analysis outcomes conclusively demonstrate that all fitting indices pertaining to the model in this study have successfully met the predefined evaluation criteria. This comprehensive validation underscores the model's outstanding and favorable fitting performance, consistent with the research conclusions of other scholars.

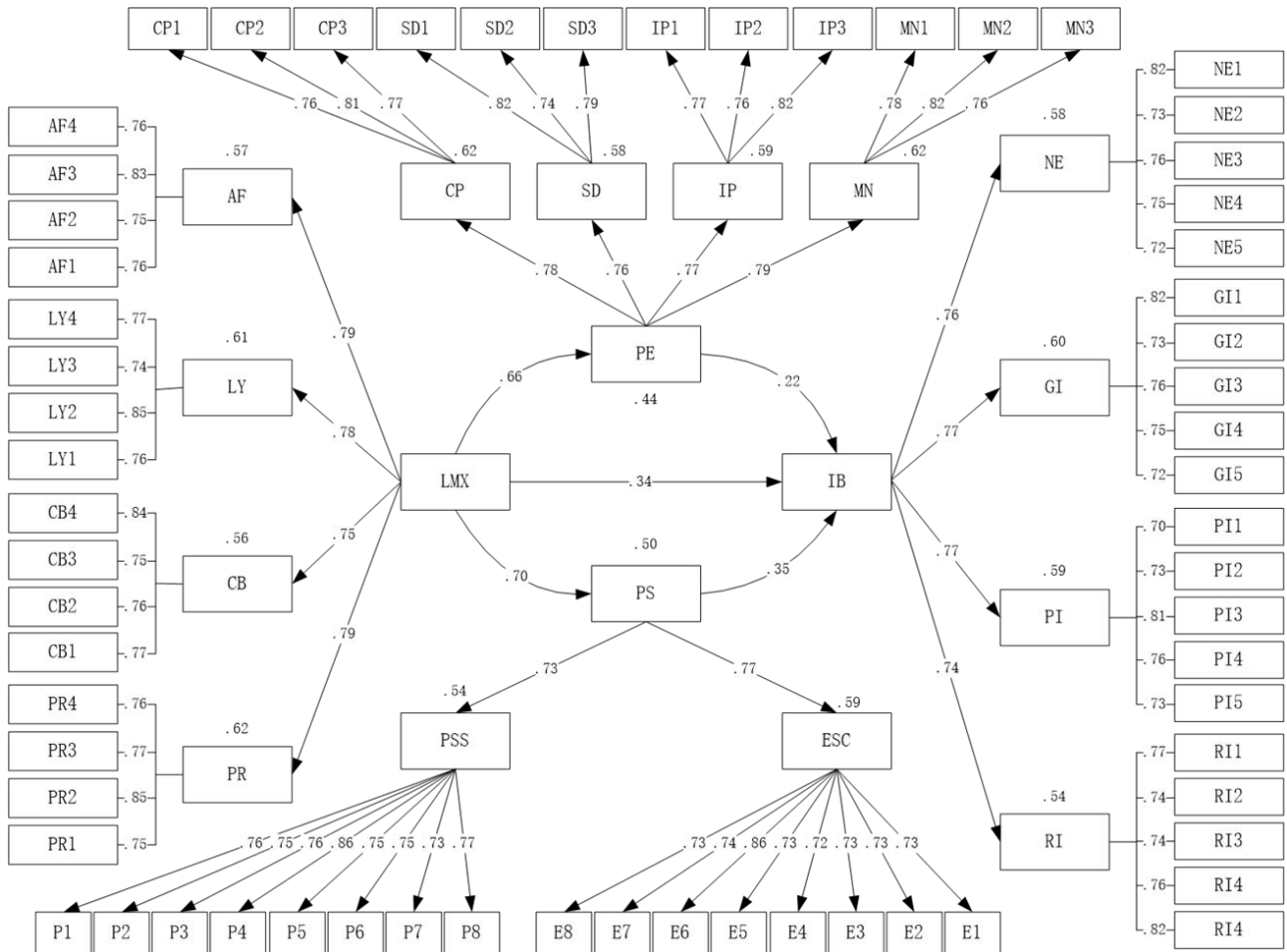


Figure 2. Structural equation model.

Table 4. Path analysis.

Paths	Non-standardized coefficient	regression	Path test results	Standard error	T-value	Beta.	p
M1	LMX -> PE		.000	.663	.055	.665	11.737***
M2	LMX-> ps		.000	.705	.061	.698	11.545***
M3	PE -> ib		.000	.223	.065	.268	4.305***
M4	Ps -> ib		.000	.353	.084	.429	5.307***
M5	LMX-> ib		.000	.343	.091	.416	4.596***

The AMOS path analysis shown in Table 4 shows that the exchange between leaders and members not only has a profound impact on members' cognition of their own ability and value (i. e., the sense of psychological authorization), the effect coefficient is as high as $\beta = .663$, and the statistical significance is $p < .05$, highlighting the positive influence that cannot be ignored; at the same time, it also significantly enhances the psychological security of team members ($\beta = .705$, $p < .05$), thereby affirming the validity of pathways 1 and 2. This underscores the pivotal role of strong leader-member rapport in fostering heightened feelings of psychological empowerment and security among educators within the academic milieu of Xi'an's universities and colleges. Meanwhile, psychological empowerment ($\beta = .223$, $p < .05$) and psychological security ($\beta = .353$, $p < .05$) both positively promote innovation behavior, which verifies path 3 and 4 and reveals their positive correlation with innovation behavior. Finally, the interaction between leaders and members

directly and significantly promotes the generation and development of innovative behavior($\beta=.343, p<.05$), which supports H1 hypothesis, namely, leader-member exchange can significantly promote innovative behavior of teachers in Xi'an universities.

4.6 Mediating effect

Table 5. (a) Intermediary evaluation analysis.

Relation of paths	Mediating variables		
LMX-> PE-> ib	PE		
LMX-> ps -> ib	PS		
	Indirect effect test		
	BootLLCI	BootLLCI	p
LMX-> PE-> ib	.083	.226	.000
LMX-> ps -> ib	.143	.348	.000

This investigation delves into the intricate web of multiple mediation pathways inherent in the model, meticulously scrutinizing each. With particular emphasis on the pathway traced in Table 4-5, the intricate link of "The interaction between leaders and members affects psychological empowerment and further innovative behavior" is subjected to a rigorous analysis. The findings reveal a pivotal role for psychological empowerment as a mediator, with its bias-corrected confidence interval spanning [0.083, 0.226], a range that is devoid of the null value, and a corresponding P-value of less than 0.05, the psychological authorization mechanism highlighted in the link of interaction between teacher leaders and members to the emergence of innovative behaviors. Its remarkable influence irrefutably verifies its extraordinary status as a key intermediary. This finding not only validates the correctness of the research hypothesis H2, but also further reveals the profound impact of complex interaction mechanisms within organizations on individual innovation behavior.

In the path of "The interaction between leaders and members affects psychological empowerment and further innovative behavior", the mediating effect of psychological safety is defined as [0.143, 0.348] with the bias correction confidence interval, which strictly excludes the statistical significance of zero value with $p<.05$, indicating that there are significant indirect effects and mediating mechanisms in this path. This finding provides solid empirical support for the research hypothesis H3, namely, psychological security serves as a pivotal mediating factor, bridging the gap between the LMX relationship and the innovative behavior of university teachers in Xi'an.

Table 6. Enumeration of aggregate, direct, and intermediary influences.

Paths	LMX->pe, ps -> IB			
Effects	Total Effect	Direct impact	The mediating role of PE	PS mediation effect
Effect size	0.738	0.346	0.155	0.241
Relative effect value		46.75%	20.65%	32.53%

Upon a thorough examination of the aggregate, direct, and intermediary effects tabulated in Table 4-6, we found that in the path of "From the interaction between leaders and members to individual psychological empowerment, and then driven by psychological security, innovative behavior is finally triggered", direct effect only accounted for 46.75% of the relative effect value, while the mediating effect of

psychological empowerment and psychological security accounted for 20.65% and 32.53% respectively. Significantly indicating that the mediating effect in this path belongs to the category of partial effect. The study found that the LMX is not the only way to predict innovative behavior, but is realized through two parallel mediating mechanisms of psychological empowerment and psychological security. It further reveals the profound influence of complex interpersonal network within organizations on individual innovation behavior.

5. Discussion

This study deepens the understanding of the internal mechanism of LMX in influencing the innovation behavior of university teachers, and contributes new perspectives and strategies to the research and practice in the field of educational management. The findings indicate that leader-member exchange significantly enhances teachers' innovation both directly and indirectly. The indirect effect is mediated by psychological empowerment and psychological security, which play crucial roles in this process. The development of this intermediary model greatly improves our comprehension of the factors driving innovative behavior among college teachers. It uncovers the strong interconnections between leader-member exchange, psychological empowerment, and psychological security, highlighting these elements as essential for a holistic understanding of faculty innovation.

This study's findings robustly confirm hypothesis 1, demonstrating that leader-member exchange significantly boosts teachers' innovative behavior^[18]. This result aligns with existing literature, which consistently underscores the importance of leader-member exchange in fostering educators' creativity. This study not only supports the core conclusions of social exchange theory and further explains the central role of high-quality interpersonal exchange in stimulating individual innovation behavior, but also reveals the vital importance of cultivating stable and healthy leader-member relationship in promoting teachers' innovation efforts and relieving professional stress and anxiety. In addition, this study also constructs a necessary support system framework for improving innovation initiative and effectiveness in the field of higher education, which has important practical guiding significance.

By testing Hypothesis 2, the dummy sample clearly defines the key role of psychological empowerment as a partial mediating effect between leader-member exchange and teacher innovative behaviour. This finding is highly consistent with previous studies and further highlights the importance of psychological empowerment as a key mediating variable. Empowering educators psychologically not only fosters a favorable mindset and internal drive towards work but also establishes a sturdy groundwork upon which innovative conduct blossoms. This alignment echoes the premise of social exchange theory, wherein a heightened leader-member interaction, mediated by psychological empowerment, fosters creativity and novel behaviors. Furthermore, this paper emphasizes that leadership and member exchange is an important environmental factor, which can promote the cultivation of teachers' psychological empowerment and enhance their innovation ability. It unveils the key significance of Psychological authorization as a positive emotional catalyst at the individual level, empowering educators to unleash their creative potential.

The current research triumphantly validated Hypothesis 3, the importance of the key mediating role of psychological safety as an indispensable bridge between the leader-member exchange relationship and innovative behaviour is illustrated. This groundbreaking discovery resonates profoundly with preceding scholarly endeavors, accentuating the paramount significance of psychological safety as a catalyst for igniting teachers' creative endeavors and fostering an environment conducive to innovation. The study points out that when teachers are in a psychologically safe working environment, their engagement, vitality and innovative thinking are significantly improved, which in turn generates more valuable ideas and behaviors,

and ultimately drives innovation. By actively creating psychological security, leaders not only enhance the trust and investment of followers, but also significantly improve their willingness to participate in innovative activities. This study contributes new perspectives and empirical support to the research in this field by deeply analyzing the intermediary mechanism of psychological security in the dynamic relationship between LMX and innovative behavior. Crucially, the present study bridges an important gap in prior research by elucidating the nuanced influence trajectory of psychological security within the intricate relationship between LMX and inventive activities. It unequivocally underscores the pivotal role of enhancing psychological security as a formidable impetus for elevating teachers' innovative capacity.

The findings highlight that leadership - specifically, the quality of leader-member exchange (LMX) - plays a critical role not only in fostering innovation, but also in shaping organizational culture and individual mental health. Leadership practices that enhance psychological empowerment and create a sense of security contribute to a positive social environment where employees feel valued, trusted, and willing to take risks. In turn, this environment supports innovation by reducing the fear of failure and encouraging creative problem solving. Therefore, leadership has a ripple effect that not only affects immediate team dynamics, but also contributes to the overall mental health and performance of individuals within the organization.

And, This study provides valuable strategic information for improving social interaction structures and leadership styles in a variety of organizational Settings. By showing how LMX impacts innovation through psychological empowerment and safety, the study highlights the importance of building strong, trust-based relationships between leaders and members. These findings apply not only to educational institutions, but also to a wide range of organizational Settings that prioritize innovation and employee well-being. Organizations can apply these insights to create supportive environments that encourage autonomy, reduce stress, and foster collaborative innovation. The strategy can be used to improve leadership practices in areas such as business management, nonprofits, and government agencies, ultimately fostering a culture of innovation and psychological safety.

6. Summary and suggestions

6.1. Summary

This research explores how Leadership-Member Exchange dynamics boost innovative endeavors among Xi'an university teachers, the dual mediation effect of psychological authorization and psychological security is analyzed in depth. The data were analysed through a questionnaire survey of 845 university teachers, combined with SPSS and AMOS software. The research not only reveals the formation mechanism of teachers' innovative behavior, but also provides important theoretical reference and practical guidance for improving the innovation ability of college teachers and the overall innovation level of the education system. To be specific:

- a) Leader-member exchange exerts a substantial and beneficial influence on the innovative behavior demonstrated by educators: Communication and interaction between senior leaders and members can inspire more teachers to display innovative behavior, which is reflected in teachers' ability to find opportunities and propose and implement innovative ideas.
- b) The pivotal intermediary function of psychological empowerment: it plays a partly mediating role between LMX and teachers' innovative behaviour. When teachers feel empowered and supported by leaders, their sense of psychological empowerment is enhanced, which in turn promotes innovative behavior.

c) The intermediary function of psychological security: it is also another important mediator between LMX and the innovative behavior of teachers. In an environment that fosters a sense of security and support, educators exhibit a greater propensity to engage in experimental thinking and implement innovative practices.

This research endeavor not only affirms the applicability of the LMX theory within the realm of education, but also reveals the importance of psychological empowerment and psychological safety as mediating variables, providing a new perspective and theoretical basis for improving teachers' innovative behavior.

6.2. Recommendations

Drawing upon the aforementioned research findings, the subsequent recommendations for further inquiry are herein proffered:

a) Strengthen the exchange relationship of leading members: the management of colleges and universities should attach importance to the communication and interaction with teachers, and establish the exchange relationship of leading members based on trust and respect. Through regular communication, feedback and incentive mechanism, teachers should enhance their support and trust in leaders, so as to stimulate their innovation motivation.

b) Enhance teachers' sense of psychological empowerment: Leaders should give teachers more autonomy and decision-making power, so that they feel empowered and trusted in their work. Provide necessary training and support to help teachers upgrade their skills and self-confidence and enhance their sense of psychological empowerment.

c) Create a safe environment for innovation: Institutions of higher learning ought to aspire to cultivate a workplace culture that fosters creativity and embraces the inevitability of failure as a stepping stone towards progress.

By setting up innovation funds and establishing innovation teams, universities should provide platforms and opportunities for teachers to practice innovation. We will strengthen psychological care and support for teachers, pay attention to their professional development and personal growth, and enhance their psychological security.

d) Further research on psychological mechanism: Future research can further explore the specific mechanism of psychological empowerment and psychological security on teachers' innovative behavior, such as case study, experimental research and other methods to dig deeper into their internal relationship. Concurrently, it is imperative to attend to the variations in teachers' innovative conduct across diverse cultural landscapes, alongside a nuanced exploration of the manifestation and impact of psychological empowerment and psychological security within varying contextual frameworks.

e) Strengthening interdisciplinary cooperation: Researchers across the disciplines of education, psychology, and management ought to forge stronger collaborations in order to collaboratively investigate the factors that influence and devise intervention strategies aimed at enhancing teachers' innovative behavior.

f) Encourage interdisciplinary collaboration: Researchers in the fields of education, psychology, management, etc., should collaborate to study the factors that influence teacher innovation behavior and develop intervention strategies to promote teacher innovation behavior. By promoting interdisciplinary collaboration, research results can be translated into practice more effectively.

The transformation and application of research results should be promoted through interdisciplinary cooperation and exchange.

In conclusion, this study provides new insights and directions for improving teachers' innovative behavior. Strengthening communication between leaders and members, fostering psychological empowerment, and creating a safe environment for innovation can go a long way towards sustainable development in education. These strategies also apply to the broader organizational environment, where leadership plays a vital role in creating an environment that supports innovation, empowerment, and mental health.

Author contributions

Conceptualization, Yanheng Zhu and Kuan-Chun Tsai; methodology, Yanheng Zhu; software, Yanheng Zhu; validation, Yanheng Zhu; formal analysis, Yanheng Zhu; investigation, Yanheng Zhu; resources, Yanheng Zhu; data curation, Yanheng Zhu; writing—original draft preparation, Yanheng Zhu; writing—review and editing, Yanheng Zhu; visualization, Yanheng Zhu; supervision, Yanheng Zhu; project administration, Yanheng Zhu; funding acquisition, Kuan-Chun Tsai. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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