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# The effect of principal transformational leadership on teacher innovative behavior: the moderator role of uncertainty avoidance and the mediated role of the sense of meaning at work

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**Introduction:** Given the rapid technological advancements and increasing global uncertainties, principals' promoting teacher innovative behavior (TIB) is fundamental for schools to enhance effectiveness and achieve sustainable competitive growth. However, previous research on the impact of principal transformational leadership (PTL) on TIB has yielded conflicting results. Drawing upon social cognitive theory and leadership substitution theory, this study constructs a model to elucidate the mediating role of teachers' sense of meaning in work (TMW) between PTL and TIB, as well as the moderating role of teachers' uncertain avoidance (TUA) in mainland China.

**Methods:** The model was examined in Chinese primary and secondary schools, with data gathered in January and July 2023. A total of 295 primary and secondary school teachers participated in this research. With Hayes' PROCESS macro, we examined all the direct and indirect paths, including moderated mediation.

**Results:** The findings confirm that PTL positively influences TIB, with TMW serving as a mediator in this relationship. Furthermore, TUA moderates both direct and indirect relationships mentioned above.

**Discussion:** These findings shed light on the underlying mechanisms through which principal transformational leadership impacts teacher innovative behavior. The implications derived from this conclusion offer valuable managerial insights for principals seeking to promote TIBs.

## KEYWORDS

principal transformational leadership, teacher innovative behavior, the sense of meaning at work, uncertainty avoidance, primary and secondary school

## 1 Introduction

Educational reformers and policymakers worldwide have long been striving to enhance teachers' instructional practice, recognizing the pivotal role of high-quality teaching in improving student learning outcomes (Leithwood et al., 2004; Bryk et al., 2010). While little agreement exists on what constitutes high-quality teaching, the literature suggests that teacher innovative practices significantly contribute to reaching a common understanding (Hattie, 2008; Moolenaar et al., 2010). The increasing demand for teachers to cultivate conducive learning environments necessitates their

generation and implementation of innovative teaching approaches (Thurlings et al., 2015). Consequently, educational leadership scholars have increasingly explored the association between school leadership and teacher behaviors to enhance teachers' innovative practices (Sebastian and Allensworth, 2012; Paletta et al., 2021).

Researchers have extensively investigated the impact of principal transformational leadership on teacher innovative behavior, as they play a crucial role in facilitating and implementing school transformation and development. However, the research findings regarding this impact are controversial, with some studies indicating a positive relationship between principal transformational leadership and teacher innovative behavior (Chang et al., 2021; Zainal and Matore, 2021; Kılınç et al., 2022), while others report no significant influence (Supermane, 2019; Messmann et al., 2022) or even an inhibitory effect on such behavior (Sudibjo and Prameswari, 2021). These discrepancies may be attributed to various factors. Firstly, the effectiveness of a specific leadership style can be influenced by employee characteristics and contextual circumstances (Thompson and Vecchio, 2009). Secondly, the previous research has primarily focused on examining how principal transformational leadership impacts teacher innovative behavior in terms of emotional commitment (Kılınç et al., 2022), self-innovation efficacy (Khan et al., 2019; Zainal and Matore, 2021), and satisfaction of basic psychological needs (Messmann et al., 2022). However, it has overlooked the significant role teachers' sense of meaning at work plays in this relationship. The sense of meaning at work is the crucial cognitive explanatory mechanism for the transformative-oriented behavior of post-1990 generation employees in mainland China (Feng, 2011). Simultaneously, authentic and enduring motivation for innovation is linked to the pursuit of meaning. Examining this sense of meaning provides deeper insights into how leadership behaviors motivate employees (Song et al., 2018). Given the importance of examining the relationship between principal transformational leadership and teacher innovative behaviors in educational practice and scholarship, this study explores the relationship between principal transformational leadership and teacher innovative behaviors in primary and secondary schools in mainland China, as well as the roles of teachers' sense of meaning at work and uncertainty avoidance. It seeks to contribute to the existing literature by providing insights into these mechanisms and their boundaries.

## 1.1 Principal transformational leadership and teacher innovative behavior in mainland China

Social cognitive theory suggests that human behavior patterns are formed through the interaction of human, environmental, and behavioral factors, with environmental factors directly influencing individual behavior. Teacher innovative behavior is a self-initiated process involving idea generation, promotion, and realization (Thurlings et al., 2015). Transformational leadership refers to principals establishing a shared vision and goals while fostering a collaborative school culture that meets teachers' needs, stimulates their growth potential, and enhances their effectiveness in driving school change (Leithwood and Jantzi, 1990). According to social cognitive theory, principal transformational leadership, characterized by establishing innovative school development objectives and fostering a collaborative school culture, can enhance teachers' efforts to seek alternative solutions to educational challenges and utilize non-traditional methods, ultimately cultivating innovative behavior.

Recent surveys suggest a significant correlation between principal transformational leadership and teacher innovative behavior. According to Al-Husseini et al. (2021), transformational leadership catalyzes creative behaviors among faculty members in Iraqi public universities. Consistent with this finding, Chang et al. (2021) have also demonstrated the positive impact of principal's transformational leadership on the innovative practices of physical education teachers in junior and senior high schools in Taiwan. The encouragement of teachers to emulate leaders and adopt them as role models is more likely among principals with a high power distance orientation, which is characterized by the utilization of impression management strategies, ambiguity in leadership roles, authoritative behavior, and decisive decision-making (Brockner et al., 2001). Based on social cognitive theory and relevant empirical findings, this study proposes:

*H1: Principal transformational leadership positively influences teacher innovative behavior in Mainland China.*

## 1.2 The mediating role of teachers' sense of meaning at work

From an optimistic psychology perspective, Steger et al. (2012) posited that the sense of work meaning encompasses an individual perception and experience of their work existential significance. This sense has been identified as a crucial motivator for employees, cultivating favorable attitudes and behaviors (Yu and Xiang, 2019). As a pivotal aspect of intrinsic motivation (Gagne et al., 1997), it enhances cognitive flexibility and resilience, leading to increased creativity (McMahon and Ford, 2013). Given its significance, extensive research has investigated situational factors that influence the meaning of work, revealing that positive leadership styles, such as moral leadership (Wang and Xu, 2019) and transformational leadership (Pradhan and Jena, 2019), have the potential to enhance employees' sense of meaning in their work. Hence, teachers' sense of meaning at work may mediate the effect of principal transformational leadership on teacher innovative behavior.

The influence of principal transformational leadership on teachers' sense of meaning at work can be explained by three factors. Firstly, transformational leaders empower employees, fostering a participatory environment conducive to decision-making, collaboration, and idea generation (Afsar et al., 2014). This enhances employees' confidence and self-efficacy (Avolio et al., 2004), leading to a stronger sense of work meaning (Woods and Sofat, 2013). Under such leadership, teachers feel motivated and empowered, experiencing a more profound sense of purpose. Secondly, transformational leaders articulate a compelling vision and communicate future goals effectively (Ghadi, 2017). This allows employees to align their values with organizational objectives, increasing their sense of work meaning. In the educational context, transformational principals collaborate with teachers to co-construct school development goals and values, integrating personal and institutional objectives. This alignment fosters teachers' shared sense of purpose, enhancing their engagement and meaning derived from work. Finally, social contagion theory posits that followers unconsciously mirror leaders' behaviors and attitudes (Bak et al., 2021). Transformational principals are positive teacher role models characterized by self-directedness and engagement in meaningful work. Their behaviors and attitudes influence teachers to adopt similar mindsets and approaches, leading to a collective sense

of meaningfulness in the workplace. Based on these reasons, we hypothesize that principal transformational leadership significantly impacts teachers' sense of meaning at work.

*H2: Principal transformational leadership positively relates to teachers' sense of meaning at work.*

The relationship between teachers' sense of meaning at work and teacher innovative behavior can be explained by three reasons. Firstly, a sense of meaning at work stimulates internal motivation, a crucial driver of innovative behavior (Amabile, 1988; Koo and Fishbach, 2012). This suggests that teachers who find meaning in their work are more intrinsically motivated to engage in innovative activities, regardless of external rewards. Secondly, a sense of meaning at work leads to more outstanding work involvement. High levels of work involvement encourage teachers to improve and implement innovative practices (Su et al., 2018; Ke and Ding, 2020). Therefore, teachers who perceive their work as meaningful are more likely to demonstrate a commitment to and engagement in innovative activities. Lastly, a sense of meaning at work can positively affect employees' organizational citizenship behavior (Ishara and Schlechter, 2007). Innovative behavior can be considered organizational citizenship behavior (Song et al., 2014). Therefore, when teachers find meaning in their work, they are more likely to engage in innovative behaviors to express their commitment to the school. Based on these reasons, we predict that teachers' sense of meaning at work is significantly associated with their innovative behavior.

*H3: Teachers' sense of meaning at work positively relates to teachers' innovative behavior.*

The social cognitive theory suggests that the social environment indirectly triggers individual behavior by activating internal psychological mechanisms (Bandura, 1997). Therefore, principal transformational leadership is likely to influence teacher innovative behavior indirectly through their psychological response mechanism, such as their sense of meaning at work. Combining Hypothesis 2 and Hypothesis 3, we propose the following hypothesis:

*H4: Teachers' sense of meaning at work plays a mediating role in the relationship between principal transformational leadership and teacher innovative behavior.*

### 1.3 The moderating role of the teachers' uncertainty avoidance

Uncertainty avoidance, a cultural value conceptualized by Hofstede, denotes how individuals from diverse cultures perceive uncertainty and novel situations as threatening (Dorfman and Howell, 1988). While Hofstede's framework reflects a broader cultural dimension, research also acknowledges individual differences within cultures (Liu et al., 2012). At the individual level, uncertainty avoidance is the degree to which one actively seeks to minimize uncertainty (Jung and Kellaris, 2004). While studies have examined the moderating role of uncertainty avoidance in the context of transformational leadership and innovation from a cultural standpoint

(Watts et al., 2019), more research is needed to explore this moderating effect from an individual perspective. Low uncertainty avoiders embrace change and novelty, challenging norms with a spirit of adventure. Conversely, high uncertainty avoiders exhibit conservatism, fear failure and risk, and prefer security over the unknown (Qu and Yang, 2015). Previous research suggests that the influence of leaders on subordinates' attitudes and behaviors is moderated by uncertainty avoidance (Zhou and Song, 2020).

Employees with high uncertainty avoidance often require significant psychological support to manage change and confront new challenges (Qu and Yang, 2015). They tend to resist exploring the unknown or adopting new methods. Principal transformational leadership plays a pivotal role by prioritizing the intellectual stimulation of teachers and facilitating the provision of crucial information and resources (Leithwood et al., 1996). This approach fosters enthusiasm among these teachers, motivating them to acquire more profound expertise and innovative abilities. The principal transformational leadership shows concern for teacher personal feelings and needs, helping those with high uncertainty avoidance overcome anxiety and threats in uncertain situations and enabling them to embrace change and new ideas (Liu and Zheng, 2016). On the contrary, teachers with low uncertainty avoidance exhibit openness toward changes and novel concepts, excel in challenging conventions by proposing innovative ideas and methodologies, and demonstrate a high level of innovation (Zhou and Song, 2020). Consequently, the impact of principal transformational leadership on teacher innovative behavior is constrained. Therefore, the following hypothesis is posited:

*H5: Teachers' uncertainty avoidance moderates the promoting effect of principal transformational leadership on teacher innovative behavior.*

For employees with high uncertainty avoidance, first of all, transformational leaders can provide them with a sense of purpose and cultivate their organizational identity, thereby enhancing their awareness of the consistency between themselves and their work, and thus affecting their sense of meaning (Schnell et al., 2013). Secondly, transformational leadership mainly focuses on tapping employees' inner consciousness and potential, empowering them to meet their higher needs (Sergiovanni, 1990), overcoming their fear of ambiguity, and thus generating positive work motivation. This, in turn, can increase their enthusiasm and greater sense of meaning in their work (Allan et al., 2016). Finally, The implementation of transformational leadership empowers employees to operate autonomously, demonstrating respect and trust toward their decisions and behaviors, thereby enhancing their authority over a wider range of resources (Bowler, 2006; Zhang, 2010), which can help them eliminate tension and anxiety in situations of uncertainty, enable them to meet expectations based on personal interests and strengths, while satisfying the need for autonomy, and ultimately stimulate their sense of meaning in work (Hackman and Oldham, 1976).

On the contrary, employees with low uncertainty avoidance are more inclined to perceive risks and uncertainties as opportunities, enabling them to engage in continuous learning and exploration (Martín et al., 2020). However, within this context, the influence of transformational leadership on stimulating their sense of work meaning is constrained. Consequently, the following hypothesis is proposed:

*H6: Teachers' uncertainty avoidance moderates the relationship between principal transformational leadership and teachers' sense of meaning at work.*

Based on the reasoning logic of H5 and H6, principal transformational leadership satisfies high uncertainty avoidance teacher need for belonging, supports and cares for them, promotes their intrinsic motivation and work willingness through professional motivation, and empowers and trusts them to perceive autonomy in their work. When these needs are met, their sense of meaning at work is stimulated, enhancing their professional skills, creative thinking, and internal motivation to work creatively (Tu and Lu, 2013). For teachers with low uncertainty avoidance, due to their heightened enthusiasm for learning and exploratory spirit toward the unknown and ambiguous, as well as their strong sense of work significance, the role of principal transformational leadership in stimulating innovation through teachers' sense of meaning at work may be insignificant. Therefore, the following hypothesis is proposed:

*H7: Teachers' uncertainty avoidance moderates the mediating effect of principal transformational leadership on teacher innovative behavior via teachers' sense of meaning at work.*

In summary, this study presents a moderated mediation model (Figure 1) to examine how the principal transformational leadership influences teacher innovative behavior through the mediating role of their sense of meaning at work and the moderating role of their uncertainty avoidance.

## 2 Research methodology

### 2.1 Data collection and sample

Starting in March 2022, the study was conducted among primary and secondary school teachers in Shenzhen and Beijing. Initially, 1,079 teachers from 30 public schools in the two cities were invited to participate in the study using an online questionnaire. During the study, all participating schools

developed policies designed to motivate teachers to innovate in their teaching. To avoid common method bias and consider the causal order of research variables, this study adopts the method of a three-wave time-lagged study. We have measured the variables in this study in different periods. For example, data on principal transformational leadership, teachers' uncertainty avoidance, and teachers' sense of meaning at work were collected in September 2021 (i.e., T1). To compensate for the missing data, data on teacher innovative behavior were collected at the two subsequent measurement points: January 2023 (i.e., T2) and July 2023 (i.e., T3). We chose a five-month interval because Chinese mainland schools generally carry out their work in the five-month-long semester. More importantly, the teacher innovative behavior process requires sufficient time.

At T1, 532 teachers participated in the questionnaire (the participation rate was 48.5%), among which 339 teachers participated in the Survey at T2 (the participation rate was 63.7%) and 307 teachers participated in the Survey at T3 (the participation rate was 57.7%). However, only 114 teachers participated in all three data collections, while 418 teachers participated in only one of T2 and T3.

Teacher innovative behavior data were collected from T2 and T3 assessments to address missing data. A subsample of 198 records with fewer or no missing values than in T3 was selected at T2, while a set of 97 complete records was gathered from T3. A t-test was conducted using gender, teaching tenure, and educational qualifications as independent variables to compare the two groups. The results showed no significant differences in demographic characteristics between the groups, allowing us to combine these data points without compromising our sample integrity.

The final sample of this research has 295 valid observations, of which 144(48.8%) are female and 151(51.11%) are males. Most of the teachers in the sample are from primary and junior school, of which 40.00% are from primary school and 33.23% are from junior school. 27.1% of the teachers held a college degree or below, 46.4% possessed a bachelor degree, and 26.5% had attained a master degree or higher level of education. As for teaching experiences, 120 teachers between 11 and 20 years of teaching experience, 94 teachers between 6 and 10 years, 63 teachers over 20years, and 16 teachers under 5 years, respectively.

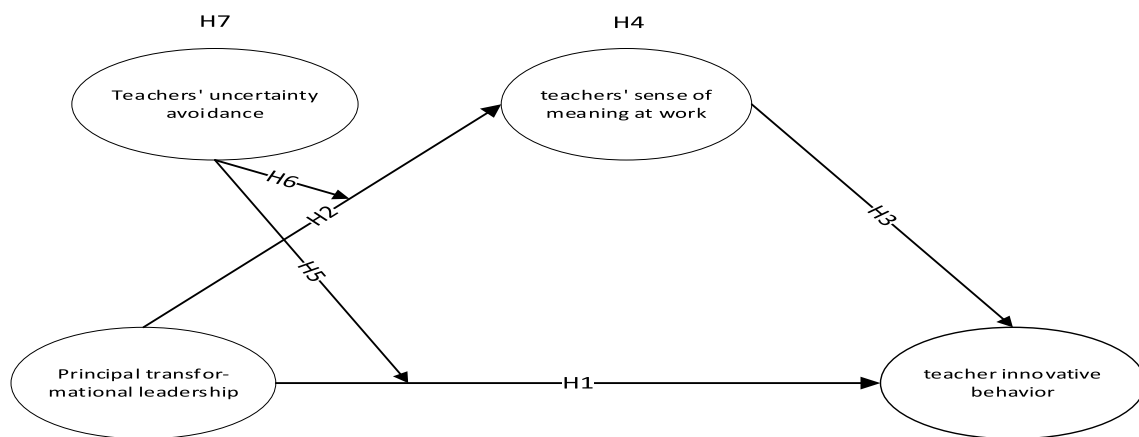


FIGURE 1  
The research model.

## 2.2 Measures

The measurement scales utilized in this study have all been published in reputable international journals. The scale tested within the Chinese context has demonstrated high levels of reliability and validity. Additionally, bilingual teachers specializing in the management field were invited to rigorously conduct “translation-back translation” of the scale, while also making necessary adjustments to certain items based on Chinese daily expression habits and sample characteristics. The reliability and validity of all scales employed herein exhibit promising results. A Likert 5-point scoring method was uniformly adopted across all scales, with scores ranging from 1 to 5 indicating an ascending level of agreement from “strongly disagree” to “strongly agree.”

### 2.2.1 Principal transformational leadership

The measurement of this variable adopts the scale prepared by Liu (2013), which is divided into four dimensions and 18 items. The details are as follows: (1) setting goals (e.g., “The principal keeps us informed about the overall direction of the school”), (2) developing people (e.g., “The principal encourages us to introduce new ideas in teaching and learning”), (3) reshaping culture (e.g., “The principal is committed to building a good school culture”), and (4) guiding teaching (e.g., “The principal regularly observes classroom activities”). The Cronbach’s  $\alpha$  of this scale is 0.859, which has a high reliability level.

### 2.2.2 Teacher innovative behavior

Considering the primary and secondary school teachers who were the subject of this study and the Chinese cultural context, following Li (2015), the scale mainly consists of 2 dimensions with 23 items: innovative idea generation (e.g., “I have many new ideas and concepts for student development”) and innovative idea implementation (e.g., “I can establish an appropriate work plan to implement new work ideas”). In this study, Cronbach’s  $\alpha$  value of this scale was 0.901, which has a high-reliability level.

### 2.2.3 Teacher’s sense of meaning at work

TMW implies that teachers’ perception of their relationship with their educational work is the extent to which they perceive the work to be of positive value and significance to them personally. Following the sub-dimension of the Psychological Empowerment Scale developed by Li et al. (2006), the scale includes three items, such as: “What I do at work is meaningful to me.” In this study, Cronbach’s  $\alpha$  value of this scale was 0.823, which has a high-reliability level.

### 2.2.4 Teachers’ uncertainty avoidance

TUA refers to the extent to which a teacher tries to avoid uncertainty to the extent possible. This variable is measured by the scale compiled by Jung and Kellaris (2004), which is specially used to measure uncertainty avoidance at the individual level. Its reliability and validity have been widely verified, with seven questions, such as “When I do not know the result, I am prone to anxiety.” In this study, the Cronbach’s  $\alpha$  value of this scale was 0.862, which has a high reliability level.

According to previous research findings, demographic variables that are likely to have an impact on teachers’ innovative behavior, such as teacher gender (Yang, 2015), years of teaching experience (Ghaith

TABLE 1 Confirmatory factor analysis results ( $N = 295$ ).

Factor Model	$\chi^2/df$	CFI	TLI	RMSEA
Four-factor model (P, U, M, I)	1.601	0.925	0.918	0.047
Three-factor model (P, U, M+I)	2.301	0.821	0.771	0.081
Two-factor model (P, U+M+I)	2.821	0.629	0.609	0.089
Single factor model (P+U+M+I)	3.602	0.511	0.495	0.128

P stands for principal transformational leadership, U stands for teachers’ uncertainty avoidance, M stands for teacher’s sense of meaning at work, and I stands for teacher innovative behavior.

and Yaghi, 1997), school type, teacher educational level were used as control variables.

## 2.3 Ethics statement

The study was conducted following the Declaration of Helsinki and approved by the Human Research Ethics Committee of Shenzhen Longgang District Education Science Research Institute. All participants voluntarily agreed to participate, provided informed consent when completing the survey, and were free to withdraw from the study at any time. Additionally, our data were anonymized to ensure participant privacy.

## 3 Results

### 3.1 Common method bias test and discriminant validity tests

Data for all variables in this study were obtained from teacher self-reports and may be subject to common method bias. Based on the suggestion of Zhou and Long (2004) and Koo and Fishbach (2012), this paper adopts Harman’s one-way test to check whether the constructs are subject to common method bias. The analysis yielded four constructs with a total explanatory power of 75.28%. The variance of the four factors ranged from a maximum of 19.32% to a minimum of 10.08%, with an average explanatory power of 15.06% per construct and a standard deviation of 1.62%, indicating no common method bias.

The variables were subjected to CFA analysis using AMOS 22.0 software, and the corresponding results are presented in Table 1. As depicted in Table 1, the four-factor model ( $\chi^2/df = 1.601$ , CFI = 0.9255, TLI = 0.918, RMSEA = 0.047) exhibits superior fit indices compared to the alternative model, indicating robust discriminant validity among the four variables and its suitability for subsequent hypothesis testing.

### 3.2 Descriptive statistics and correlation analysis

SPSS20.0 was used to analyze the data, and the means, standard deviations, and correlation coefficient matrix for each variable are

shown in Table 2. Mean scores for principal transformational leadership, teachers' sense of meaning at work, teachers' uncertainty avoidance, and teacher innovative behavior ranged from 3.57 to 4.16. Correlation analysis showed that principal transformational leadership was significantly and positively correlated with teacher's sense of meaning at work ( $r=0.54, p<0.001$ ), teachers' uncertainty avoidance ( $r=-0.65, p<0.001$ ), and teacher innovative behavior ( $r=0.32, p<0.001$ ). Teachers' sense of meaning at work was significantly and positively related to teachers' uncertainty avoidance ( $r=-0.54, p<0.001$ ) and innovative behavior ( $r=0.50, p<0.001$ ). Teachers' uncertainty avoidance and teacher innovative behavior ( $r=-0.36, p<0.001$ ) were significantly and positively correlated. The results indicated that the correlation coefficients between the variables ranged from 0.32 to 0.65, were moderately highly correlated, and reached the significance level, and the research hypotheses 1, 2, and 3 were initially supported.

### 3.3 Test of main effect and mediation effect

SPSS20.0 was used to conduct a hierarchical regression analysis of the main and mediation effects to verify H1 to H4. The regression results are shown in Table 3. Model 1 shows that principal transformational leadership has a significant positive impact on teacher innovative behavior ( $\beta=0.131, p<0.001$ ), H1 is supported; Model 5 indicates principal transformational leadership is significantly positively correlated with teachers' sense of meaning at work ( $\beta=0.116, p<0.001$ ), H2 is supported. According to Model 4, teachers' sense of meaning at work significantly positively impacts teacher innovative behavior ( $\beta=0.232, p<0.01$ ), and H3 is supported. According to Model 2, when teachers' sense of meaning at work is added based on Model 1, a significant positive correlation exists between teachers' sense of meaning at work and teacher innovative behavior ( $\beta=0.206, p<0.001$ ). In this case, the positive impact of principal transformational leadership on teacher innovative behavior decreases ( $\beta=0.118, p<0.01$ ), but it is still significant. Therefore, teachers' sense of meaning at work partially mediates the relationship between principal transformational leadership and teacher innovative behavior. Thus, H4 is supported. In this study, the Bootstrap plug-in of the PROCESS program was used to select 5,000 times to verify further the mediating effect randomly: the direct effect value of principal transformational leadership on teacher innovative behavior was 0.115, the confidence interval was [0.125, 0.306], excluding 0, and the direct effect was significant. When teachers' sense of meaning at work was added, the indirect effect value was 0.105, and the confidence interval was [0.034, 0.175], excluding 0, indicating a significant indirect effect. This indicates that the influence of principal transformational leadership on teacher innovative behavior is

mediated through teachers' sense of meaning at work, and H4 is further supported.

### 3.4 Test of moderation effect

The moderating effect of teachers' uncertainty avoidance on the relationship between principal transformational leadership, teachers' sense of meaning at work, and innovative behavior is tested according to the method described by Wen et al. (2005). After centralized processing, the cross-variables involved were conducted stepwise regression to verify hypothesis 5 and hypothesis 6. The results of regression analysis are shown in Table 2. Model 3 shows that the interaction between principal transformational leadership and teachers' uncertainty avoidance positively correlates with teacher innovative behavior ( $\beta=0.101, p<0.01$ ). Therefore, hypothesis 5 is supported. As can be seen from Model 7, the intersection term between principal transformational leadership and teachers' uncertainty avoidance is significantly positively correlated with teachers' sense of meaning at work ( $\beta=0.205, p<0.01$ ). Therefore, hypothesis 6 is supported.

To more intuitively understand the moderating effect of teachers' uncertainty avoidance, this study used the simple slope analysis method, in which the average value of teachers' uncertainty avoidance is taken one standard deviation on the left and right, the sample data are divided into high and low uncertainty avoidance groups, and then TIB (TWM) regression analysis with PTL was conducted separately for each group. It can be seen from Figures 2, 3 that the slope of the dashed line represented by high uncertainty avoidance is greater than the slope of the solid line represented by low uncertainty avoidance; that is, the principal transformational leadership has a more significant impact on the sense of teachers work meaning and innovative behavior with high uncertainty avoidance than teachers with low uncertainty avoidance. Therefore, Uncertainty avoidance has a boundary effect on the relationship between teachers' sense of work meaning and innovative behavior influenced by the principal transformational leadership.

### 3.5 Test of moderated mediation effect

The moderating effect of uncertainty avoidance on the mediating effect of teachers' sense of meaning at work was tested using the method described in the literature by Edwards and Lambert (2007). After adding/subtracting one standard deviation from the uncertainty avoidance mean value, Bootstrap randomly selected 5,000 times to calculate the confidence interval of the difference between high and low mediation effect values. The relevant results are shown in Table 4. As can be seen from Table 4, when teachers' uncertainty avoidance is high, the mediating effect value of teachers' sense of meaning at work

TABLE 2 Descriptive statistics and correlation analysis (N = 295).

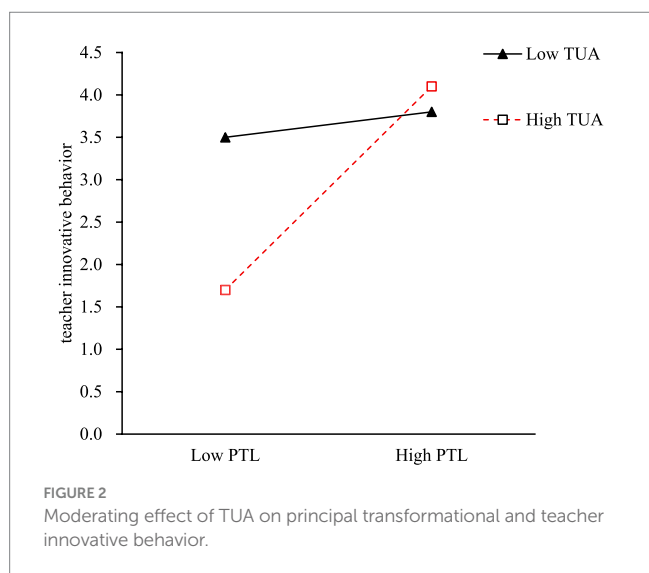
Variable	M	SD	1	2	3	4
Principal transformational leadership	3.57	0.41	1			
Teacher's sense of meaning at work	4.16	0.36	0.54***			
Teachers' uncertainty avoidance	4.39	0.44	-0.65*	-0.54**	1	
Teacher innovative behavior	4.02	0.26	0.32***	0.50**	-0.36***	1

\*, \*\*, \*\*\*, respectively, represents  $p<0.05, p<0.01, p<0.001$ .

TABLE 3 Moderated mediation model testing.

Antecedents	Y (TIB)				M (TMW)		
	Model1	Model2	Model3	Model4	Model5	Model6	Model7
Gender*	-0.551(0.009)*	-0.541(0.011)*	-0.544(0.007)*	-0.549(0.025)*	-0.113(0.019)*	-0.124(0.029)*	-0.119(0.018)*
Educational level	-0.102(0.119)	-0.103(0.221)	-0.001(0.435)	-0.001(0.114)	-0.303(0.439)	-0.243(0.274)	-0.273(0.059)
Teaching experience	0.004 (0.422)*	0.005(0.812)*	0.003(0.779)*	0.006(0.556)*	0.062(0.427)*	0.057(0.058)*	0.060(0.743)*
PTL	0.131(0.444)***	0.118(0.527)**	0.101(0.634)		0.116(0.449)***	0.114(0.871)***	0.101(0.223)***
TMW		0.206(0.447)***	0.115(0.435)***	0.232(0.541)**			
TUA			-0.102(0.274)*			-0.142(0.437)*	-0.106(0.452)*
TUA*PTL			0.101(0.175)**				0.205(0.388)**
F	13.126**	13.338**	12.556**	13.264**	21.055**	19.268**	18.203**
R <sup>2</sup>	0.255	0.291	0.312	0.261	0.261	0.305	0.327
ΔR <sup>2</sup>		0.036**	0.021**			0.044**	0.022**

① Male teachers serve as the reference category. ② The first number in the regression results represents the standardized regression coefficient (β), followed by the standard deviation (SE) in parentheses. ③ The asterisk is used to indicate the significance level, where \*, \*\*, and \*\*\*, respectively, represent  $p < 0.05$ ,  $p < 0.01$ , and  $p < 0.001$ .



is 0.112, the lower limit of 95% CI is 0.044, the upper limit is 0.158, and the confidence interval does not contain 0, so the mediating effect value is significant. When teachers' uncertainty avoidance is low, the mediating effect value of teachers' sense of meaning at work is 0.017, the lower 95% CI is -0.023, the upper limit is 0.064, the confidence interval contains 0, and the mediating effect value is insignificant. In addition, the difference between high and low effect values of uncertainty avoidance is 0.095, the lower limit of 95% CI is 0.012, the upper limit is 0.158, the confidence interval does not contain 0, and the difference between high and low effect is significant. Therefore, uncertainty avoidance moderates the mediating effect of teachers' sense of meaning at work. Thus, hypothesis 7 is supported.

## 4 Discussion

Based on the survey data, this study shows the positive impact of principal transformational leadership on teacher innovative behavior, the mediating role of teachers' sense of meaning at work, and the moderating effect of teachers' uncertainty avoidance. The following

will discuss these results with existing relevant studies and theories to draw the research conclusions.

### 4.1 The impact of principal transformational leadership on teacher innovative behavior

In line with our expectations, principal transformational leadership positively and significantly impacts the innovative behavior of primary and secondary public school teachers in mainland China. This finding aligns with studies in Peninsular Malaysia (Supermane, 2019; Zainal and Matore, 2021), Taiwan China (Chang et al., 2021), but contrasts with research in the Netherlands (Messmann et al., 2022). Differences in respondents' power distance culture may explain this discrepancy. According to Hofstede's classification, Malaysia and China belong to high-power distance cultures, while the Netherlands falls under low-power distance cultures (Hofstede and Bond, 1984). Leaders in high-power distance countries like Malaysia and China strongly influence organizational units and individuals (He and Zhang, 2017). Consequently, in mainland China's primary and secondary schools, principal transformational leadership excels in collaborating with teachers to construct the school development vision and goals, modeling the school development philosophy, stimulating teachers to challenge traditional inertia, fostering a nurturing school atmosphere, and effectively stimulating teacher inherent motivation to innovate, leading to the emergence of innovative consciousness, ideas, and actions in education and teaching.

### 4.2 The mediating role of the teacher's sense of meaning at work in principal transformational leadership on teacher innovative behavior

This study revealed that the influence of principal transformational leadership on teacher innovative behavior is partially mediated by teachers' sense of meaning at work. This finding aligns with previous research indicating that employee psychological empowerment,

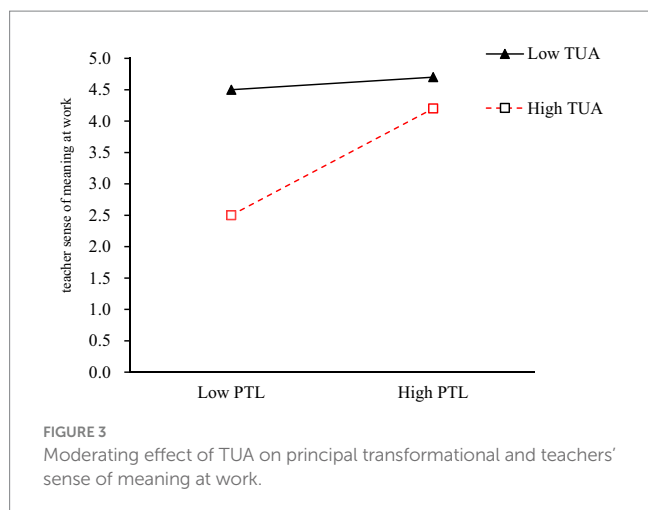


TABLE 4 The mediating effect test of teachers' sense of meaning at work under different levels of uncertainty avoidance (N = 295).

Uncertainty avoidance	PTL→TMW→TIB			
	Effect value	SE	LLCI	ULCI
High (+1SD)	0.112	0.058	0.044	0.158
Low (-1SD)	0.017	0.020	-0.023	0.064
Difference value	0.095	0.019	0.012	0.158

which encompasses a sub-dimension of sense of work meaning, mediates the relationship between transformational leadership and employee innovation behavior (Saeeda et al., 2019; Begum et al., 2020). Additionally, it supports prior studies suggesting that sense of work meaning acts as a mediator in the leader-employee behavior relationship (Ghadi et al., 2013; Han et al., 2020). In addition, the findings of this study demonstrate that a sense of meaning serves as a partial mediator in the relationship between principal transformational leadership and teacher innovative behavior, thereby highlighting the intricate process through which leadership factors influence teachers' psychological state. Further investigation is warranted to explore other significant mediating variables linking principal transformational leadership with teacher innovative behavior in our future research.

Specifically, this study demonstrates a positive correlation between principal transformational leadership and teachers' sense of meaning at work. As the level of principal transformational leadership increases, so does the teacher's sense of meaning at work. This supports the social cognition theory, which posits that the external working environment can shape individual sense of meaning. Prior research has shown that transformational leadership can awaken employee inner potential, encourage them to transcend their interests and align their behavior with the overall interests of the organization (Grant, 2012). In mainland China's primary and secondary schools, the principal influences teachers the most. When teachers perceive principal transformational leadership, it enhances their job satisfaction and organizational commitment (Koh et al., 1995), ultimately improving their sense of meaning at work.

The mediation model found a positive correlation between teachers' sense of meaning at work and their innovative behavior. This

suggests that the sense of meaning at work significantly impacts teacher innovative behavior. Previous research has reported that the sense of meaning at work is crucial in educational settings, predicting factors such as teacher work engagement, burnout, stress, performance, and graduates' resilience (Lavy and Ayuob, 2019; Lavy, 2022). Our findings further confirm that the sense of meaning at work is a crucial factor influencing teacher innovative behavior. According to the Broadened-Build theory of positive emotions (Fredrickson, 2001), a positive mental state generates positive energy, which helps individuals break free of constraints and stimulates new ideas, ultimately leading to more diverse behaviors.

### 4.3 The moderating role of the teachers' uncertainty avoidance in principal transformational leadership on teacher innovative behavior

This study indicates that teachers' uncertainty avoidance not only impacts the relationship between principal transformational leadership and teacher innovative behavior but also modifies the impact of principal transformational leadership on teacher innovative behavior through their sense of meaning at work. This aligns with previous research (Zhang and Zhou, 2014; Wang, 2020) and supports the theoretical framework of leadership substitution theory, which suggests that employee characteristics can enhance or weaken the effectiveness of leadership behavior on employees (Dionne et al., 2002). In this study, the employee characteristic is teachers' uncertainty avoidance, and the effectiveness of leadership behavior on employee variables includes teacher innovative behavior and teachers' sense of meaning at work. This means that the predictive effect of principal transformational leadership on teacher innovative behavior and teachers' sense of meaning at work varies based on teachers' uncertainty avoidance levels.

From an individual work values perspective, this study investigates the influence of principal transformational leadership on teacher innovative behavior by considering teachers' uncertainty avoidance as a lens. Our findings indicate that uncertainty avoidance acts as a boundary condition, positively moderating this relationship. This finding is consistent with prior research conducted by Wang and Luo (2017), highlighting the importance of incorporating individual characteristics when examining the impact of leadership factors on employee innovation behavior. These findings are because teachers have different preferences for uncertainty avoidance to different degrees. Teachers with low uncertainty avoidance can adapt to the dynamic environment and pursue educational innovation, and principal transformational leadership has little influence on them. On the contrary, teachers with high uncertainty prefer to seek stability and formal rules and do not tolerate opinions and behaviors that deviate from the right path. The trust and guidance from principal transformational leadership will improve their motivation and willingness to innovate.

In the hypothesized model, the moderating point of teachers' uncertainty avoidance played a role in the first half of the mediation effect; that is, the relationship between principal transformational leadership and teacher's sense of meaning at work depends on the level of teachers' uncertainty avoidance. The findings indicate that the impact of principal transformational



leadership on enhancing teachers' sense of work meaning is more pronounced among individuals with low uncertainty avoidance. Teachers with high uncertainty avoidance tend to prefer the traditional "command execution" management style, making it challenging to experience a sense of meaning in their work. However, when they are led by transformational principals who trust and empower them, they are given more freedom and encouragement to engage in their work actively. This can partially alleviate their negative emotions, ignite their enthusiasm, and ultimately enhance their perception of the meaningfulness of their work. On the other hand, teachers with low uncertainty avoidance value autonomy more and possess better adaptability in dynamic environments. They also have a stronger sense of meaning in their work than those with high uncertainty avoidance. Consequently, principal transformational leadership has a less pronounced motivating effect on the sense of work meaning for teachers with low uncertainty avoidance.

## 5 Theoretical contributions

Our findings contribute to transformational leadership and innovative behavior literature.

First, this study extends the innovation-leadership theory (a theoretical framework exploring the impact of leadership styles on innovation and elucidating the underlying mechanisms connecting them) to the field of public primary and secondary schools in mainland China, demonstrating that principal transformational leadership can promote primary and secondary school teacher innovative behaviors in a centralized cultural context, positively responding to scholars' view that transformational leadership is a situational variable with different leadership efficacies in different contexts; as well as the research recommendations to test the effectiveness of specific leadership styles according to specific industries, regions, job nature, etc., to test the research proposal of the efficacy of specific leadership styles (Wang et al., 2013).

Second, our study provides a fresh perspective on how teachers' sense of meaning at work can motivate them to innovate under the influence of principal transformational leadership. Previous studies have examined the motivational and emotional mechanisms behind teacher innovative behavior influenced by principal transformational leadership, but they have overlooked the role of teachers' sense of meaning. Innovation is inherently uncertain and risks failure (Tierney and Farmer, 2002). Only by stimulating teachers' sense of meaning at work can transformational leadership effectively translate organizational requirements for innovation into internal demands for employees, leading to sustainable and successful innovation. Therefore, this study proposes that teachers' sense of meaning at work acts as the mediating mechanism through which principal transformational leadership stimulates teacher innovative behavior. This sheds light on the "black box" of principal transformational leadership in driving teacher innovative behavior, enhances our understanding of the relationship between transformational leadership and unique extra-role behavior, and complements theoretical research on motivation provided by a sense of work meaning to drive individual innovative behavior.

Third, our findings suggest that teachers' uncertainty avoidance plays a crucial role in strengthening or weakening the expected

response to perceived transformational leadership. Previous research has overlooked subordinate individually held cultural values, which may be relevant to the leader influence and assimilation. Principal transformational leadership substantially impacts the sense of work meaning and innovative behavior of teachers with low uncertainty avoidance compared to teachers with high uncertainty avoidance. In other words, principals are more likely to influence teachers with high uncertainty avoidance through their transformational leadership style. This study not only addresses scholars' suggestions to explore potential moderating mechanisms of cultural traits on the relationship between organizational variables and innovative activities (Aman et al., 2018; Lei et al., 2020) but also contributes valuable insights into the limited research on environmental or individual factors that can affect school leadership practices (Leithwood et al., 2010; Harris and Jones, 2018). Furthermore, this research enriches our understanding of situational factors influencing the effectiveness of employee innovative behavior under transformational leadership.

## 6 Implications for practice

The findings of this study offer several critical insights for promoting teacher innovation, reinforcing principal influence on teacher behavior improvement, and driving organizational change within schools, considering the vital role of school culture.

**Cultivating Transformational Leadership in Principal Development: Shaping an Innovative School Culture.** Transformational leadership fosters an innovative school culture that encourages and sustains teacher innovation. Principals who embody this leadership style can inspire teachers to engage in innovative work behaviors, ultimately enhancing the quality of education and teaching and promoting staff stability. To cultivate transformational leadership among principals, education administrations should prioritize recruiting candidates with inherent transformational qualities and provide targeted professional development opportunities. Principal training institutions should design comprehensive programs that emphasize the application of vision- and incentive-oriented strategies, fostering a collaborative and dynamic school environment where influence supersedes authority. When assessing principal performance, special attention should be given to their ability to articulate and communicate a compelling school vision that resonates with teachers and stakeholders. This shared vision is the foundation for an innovative school culture, aligning individual efforts toward common goals and creating a collective sense of purpose. Moreover, principals should model continuous learning and innovation, encouraging teachers to embrace new ideas and approaches in their professional practice.

**Enhancing Teachers' Sense of Meaning at Work: Nurturing a Supportive and Engaged School Culture.** To promote teacher innovation, principals must enhance teachers' sense of meaning at work, recognizing its profound influence on their innovative behavior. This can be achieved by empowering teachers to develop personalized career plans, setting clear and attainable goals, and providing necessary resources and support. By linking hard work to tangible accomplishments and personal growth, principals can instill resilience in teachers and foster a supportive, engaged school culture that values and rewards innovation.

**Adapting Leadership Styles to Individual Differences: Cultivating a Diverse and Inclusive School Culture.** The contingency leadership

theory underscores the importance of leaders adapting their styles to different environments and individuals. In promoting organizational change in schools, principals should be mindful of their teachers' diverse characteristics and values, tailoring their leadership approaches accordingly. This study highlights the moderating effect of uncertainty avoidance on the relationship between transformational leadership and a teacher's sense of purpose at work and innovation. Principals should thus employ differentiated measures and precise management techniques that cater to teachers' varying levels of uncertainty avoidance.

Principals can create a structured, predictable environment for highly uncertainty avoidance teachers with clear task definitions, well-defined roles and responsibilities, and minimized uncontrollable factors. This approach helps build trust and reduces anxiety, allowing these teachers to contribute effectively to the organizational change process. Conversely, principals can offer more autonomy to teachers with lower uncertainty avoidance tendencies, assigning complex tasks that challenge them to think creatively and take calculated risks. Such an adaptive leadership approach fosters a diverse and inclusive school culture that acknowledges and leverages individual strengths, ultimately enhancing the capacity for organizational change.

In conclusion, the successful promotion of teacher innovation, reinforcement of principal influence on teacher behavior improvement, and facilitation of organizational change in schools relies on a deep understanding and strategic manipulation of school culture. By cultivating transformational leadership, enhancing teachers' sense of meaning at work, and adapting leadership styles to individual differences, principals can create a supportive, innovative, and inclusive school culture conducive to lasting organizational change.

## 7 Limitations and future research

The current paper has some limitations that must be considered before interpreting the results. Firstly, although the data is collected from multiple sources and time points, it still needs to be more cross-sectional, limiting its ability to establish causality. Future studies can use diary methods and experimental approaches for verification. Secondly, the questionnaire items are self-assessed by teachers, which may impact the results despite no serious common method bias. Future articles can adopt mutual evaluation and scoring between leaders and teachers to reduce homologous variance. Thirdly, this study analyzed how principal transformational leadership influences teacher innovative behavior. Future studies could further analyze the links between principal transformational leadership and various stages of the teacher innovation process, such as idea generation, promotion, and implementation. It would also be valuable to study the influence of four dimensions of principal transformational leadership (goal setting, personnel development, individualized care, and teaching management) on innovative teacher behavior and its internal mechanism.

## 8 Conclusion

Based on a sample of 295 primary and secondary school teachers in mainland China, this study was analyzed using SPSS and its program Process. The following conclusions were drawn: (1) Principal

transformational leadership significantly impacts teacher innovative behavior. (2) The teacher's sense of meaning at work partially mediated the relationship between principal transformational leadership and teacher innovative behavior. (3) The teachers' uncertainty avoidance moderated the relationship between principal transformational leadership and teacher innovative behavior. (4) The teachers' uncertainty avoidance moderates the mediating effect of principal transformational leadership on teacher innovative behavior via teachers' sense of meaning at work.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical approval was not required for the studies involving humans because we only conducted questionnaires and this study did not involve human clinical trials or animal experiments. In accordance with the Declaration of Helsinki, the participants provided their written informed consent to participate in this study. Confidentiality and anonymity of the survey subjects were ensured. All participation is voluntary. The studies were conducted in accordance with the local legislation and institutional requirements.

## Author contributions

YB: Writing – original draft, Writing – review & editing.

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## Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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