



The impact of meaning in life on preservice teachers' innovative behavior: the chain mediating effects of career calling and learning engagement

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Abstract

The cultivation of innovation ability among preservice teachers is crucial for the modernization of Chinese education, and the neglect of nonintellectual factors constitutes a key determinant of the inadequate training outcomes. Based on the self-determination theory, this study constructs a theoretical model with meaning in life as the independent variable, innovative behavior as the dependent variable, and career calling and learning engagement as the mediating variables to explore ways to stimulate innovative behavior. We used four scales of meaning in life, innovative behavior, career calling and learning engagement to investigate preservice teachers, and collected 2516 valid data. The results show that the meaning in life has a positive predictive effect on innovative behavior. The effect of meaning in life on innovative behavior can be mediated by career calling and learning engagement independently as well as through the chain mediation of 'career calling → learning engagement'. The findings indicate that the innovative behavior of preservice teachers is not only affected by the meaning in life, but also closely related to their career calling and learning engagement. To better cultivate the innovation ability of preservice teachers, educational policymakers and administrators should focus on fostering their meaning in life, enhancing their career calling, and promoting learning engagement.

Keywords Preservice teachers · Meaning in life · Innovative behavior · Learning engagement · Career calling

Introduction

Innovation is an inexhaustible driving force with regard to the development and progress of a country. As the concept of talent evolves, society places greater emphasis on the knowledge, ability, quality and innovation ability of talented individuals. In the contemporary global landscape, the pursuit of comprehensive national power fundamentally involves competition for exceptional and inventive human capital. Fostering students' innovation abilities is crucial in

the context of education, with teachers bearing the responsibility for cultivating such capabilities. Teachers' innovation abilities affect not only their ability to implement educational innovations but also students' level of development in this area (Zhu et al., 2022). Developing teachers' innovation abilities is key to basic education reform (Yang, 2008). The cultivation of innovation ability among preservice teachers is crucial with regard to addressing the pressing demand for innovative educators resulting from China's educational modernization.

Innovative behavior, also known as the power of innovation in action (Slåtten, 2011), is considered to be a reliable measure of an individual's capacity for innovation (Choi et al., 2011). According to the widely accepted definition proposed by Scott and Bruce (1994), innovative behavior encompasses the generation of original ideas and their successful implementation in practical contexts. The explicit nature of innovative behavior facilitates its comprehension and evaluation using self-reported assessments of research participants. Moreover, interest in the task of cultivating

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preservice teachers' innovative behaviors in China has been increasing for many years. The factors influencing individual innovative behavior include not only cognitive factors such as knowledge and skills but also internal noncognitive factors, which serve as important internal motivating factors. However, educational administrators have focused more on improving preservice teachers' intellectual attributes, such as knowledge and skills, while neglecting the significance of nonintellectual factors in this context. This situation has resulted in ineffective attempts to cultivate preservice teachers' innovative behavior. Consequently, investigating the internal noncognitive factors that affect the innovative behaviors of preservice teachers is helpful with regard to identifying novel practical avenues for fostering their innovative behaviors.

Theoretical background and research hypotheses

Previous studies on the factors influencing innovative behavior have focused primarily on external factors, such as leadership style (Wang et al., 2023) and innovation climate (Qiao et al., 2022), while neglecting the role of individual variables (Thuan & Thanh, 2019). The individual attributes of innovative behavior increase the degree to which individual cognition and beliefs affect such behavior (Liu & Xu, 2022). Self-determination theory (SDT) (Ryan & Deci, 2000) posits that human behavior is driven primarily by internal autonomous motivation rather than by external rewards or punishments. The purpose of life is to discover meaning in life (Victor, 2003). Meaning in life serves as the intrinsic motivation that drives our behavior (Fiorito et al., 2021). Our love and pursuit of life empower us to persevere through difficulties and challenges while continuously experimenting with innovative approaches, resulting in innovative behavior. Self-determination theory provides valuable theoretical support for research on the impact of meaning in life on innovative behavior (Ryan & Deci, 2000). According to self-determination theory, intrinsic motivation encompasses three essential needs: affiliation, autonomy, and competence (Ryan & Deci, 2000). When these three needs are met, individuals experience happiness and fulfillment, leading to stronger behavioral motivation. From an affiliation perspective, a meaningful life represents the foundation for answering the question “what makes life worthwhile” (Wenzel & La Motte-Kerr, 2021). Individuals with a deep comprehension of and insight into the complexities of life are inclined to actively pursue employment opportunities that are congruent with their personal values and aspirations. As a result, such individuals are more inclined to integrate into the work environment

and establish positive interpersonal relationships (Wenzel & La Motte-Kerr, 2021). This heightened sense of affiliation fosters feelings of security and enhances their career calling. Autonomy constitutes a crucial aspect of intrinsic motivation, as it refers to an individual's ability to choose and control his or her behavior based on personal interests and values. When individuals have well-defined values, life goals, and a comprehensive understanding and expectation of their career trajectory, they perceive themselves as initiative-taking participants rather than passive learners throughout the educational process (Pei & Zhao, 2015). Such autonomy can enhance individual engagement in learning activities. By investing more time and effort in learning endeavors, individuals can improve their knowledge and skills, thus enhancing their sense of competence. This enhanced sense of competence stimulates innovative thinking and entrepreneurial behavior since such individuals believe in their capacity to achieve goals related to innovation or entrepreneurship (Uppathampracha & Liu, 2022).

Based on the preceding analysis, we believe that meaning in life, career calling, and learning engagement are key factors influencing innovative behavior. However, no studies have incorporated all four variables—meaning in life, career calling, learning engagement, and innovative behavior—into one theoretical model. Therefore, this study uses self-determination theory (SDT) to construct a theoretical model to explore the effect of preservice teachers' meaning in life on their innovative behavior. The findings of this research can contribute to the tasks of optimizing training methods for preservice teachers, fostering their innovative behavior, and enhancing their innovation capacity.

The relationship between meaning in life and innovative behavior

Meaning in life is a subjective experience that leads individuals to feel that their existence exhibits purpose, value, direction, and intelligibility (Martela & Steger, 2016). Meaning in life is fundamental to happiness and has received significant attention not only in the fields of religion and philosophy but also in psychology (Hee & Sung-hyun, 2017). According to Steger et al. (2006), meaning in life emerges when people understand or perceive the significance of life and thus become aware of their purpose, mission, and goal in life. When individuals learn about themselves and the world around them, recognize their uniqueness as individuals within this world, and determine what they aspire to achieve in life, they experience a sense of meaning (Steger et al., 2008). This experience of meaning in life can alleviate the emptiness of individual existence (Kleftaras & Psarra, 2012). Heintzelman and King (2014) argued that the definition of meaning in life includes at least

two dimensions: purpose and importance. Purpose is associated with the motivational dimension of meaning in life and directs individuals to invest their energy in future value. Meaning in life is also considered to be a “core human motivation” (George & Park, 2017), which provides people with constant motivation to continue working toward their goals.

The process of acquiring meaning in life involves creating or making meaning in the face of adversity, suggesting that meaning in life is associated with creativity (Zhang & Li, 2018). Individuals’ meaning in life is significantly and positively correlated with positive emotions (Zhao et al., 2017), and individuals with a strong sense of meaning experience more positive emotions (Arnone et al., 2011). According to Fredrickson’s (2001) broaden-and-build theory, positive emotions can expand an individual’s momentary mind-action range, thereby enabling them to acquire lasting personal resources (such as intellectual, physical, psychological, and social resources) and promoting individual innovative behavior (Slatten, 2011). The effect of meaning in life on innovative behavior is significant. Nevertheless, the extant literature lacks sufficient investigations into the correlation between the meaning in life exhibited by preservice teachers and their innovative behavior. Consequently, it is imperative to conduct empirical research to examine this relationship. In conclusion, the preceding analysis leads us to propose the following hypothesis.

H1 Meaning in life has a positive predictive effect on innovative behavior.

The mediating role of career calling

Career calling is a transcendental calling that both emanates from and transcends the self, which involves a profound sense of purpose or significance, emphasizes values and goals that focus on others, and includes serving as a fundamental source of motivation that encourages the individual to play a distinct life role (Dik & Duffy, 2009). The concept of career calling has received significant attention in the fields of organizational behavior and occupational psychology due to its positive impact on individual innovative behavior, professional success, work status, and performance (Zhou et al., 2020). As an individual’s psychological attitude toward a particular type of work, career calling can serve as a guiding force that combines the individual’s career with a broader sense of meaning and purpose in life. Its aim is to help others or promote the greater good through the individual’s chosen profession (Dik & Shimizu, 2019). A teacher’s career calling is characterized not only by career calling in general but also by transcendence. Educators who experience a career calling can perceive the value

and meaning of their work itself and are more concerned with the satisfaction of their inner needs and the realization of their self-worth (Zhang, 2012). Career calling can serve as both a cause and an outcome (Li et al., 2021). The source of career calling may lie in societal demands or in the individual him- or herself (Dik & Duffy, 2009). Steger et al. (2010) conducted a study on college students and reported a positive correlation between career calling and meaning in life. Meaning in life serves as a fundamental driving force that promotes career calling (Zhang et al., 2017). By pursuing meaning in life, individuals discover the unique value of their existence in the world and identify the goals that they should strive to achieve (Heine et al., 2006). Bott and Duffy (2014) revealed that meaning in life predicted individuals’ perceptions of calling. By conducting a cross-lagged analysis of 473 Chinese university students, Zhang et al. (2017) showed that meaning in life mediates the relationship between future work self and career calling. These authors also found that meaning in life significantly predicts an increase in career calling, while career calling does not predict individual meaning in life. Li et al.’s (2021) study revealed that meaning in life mediates the relationship between trait gratitude and career calling among Chinese university students.

As a predictive variable, career calling can significantly and positively predict individuals’ innovative behavior (Liu & Xu, 2022). According to motivation theory, organizational members’ involvement in innovation activities is based on their specific values and motivations; this description is similar to the definition of career calling (Liu et al., 2021b). Career calling is important for both current students and working adults (Duffy & Dik, 2013) and can increase the individual’s internal motivation to work and encourage the individual to develop a more cheerful outlook toward work, thus promoting innovative behavior (Duffy et al., 2015). Individuals with a strong career calling are more inclined to perform demanding tasks, leading to the generation of inventive concepts and an increased likelihood of those individuals engaging in innovative conduct (Duffy et al., 2016). Individuals who are driven by career calling are guided by their inner values when selecting a job or career, which is linked to their internal motivation for autonomy (Duffy et al., 2018). For preservice teachers, meaning in life is reflected in their love of and dedication to the cause of education (Wong, 2012). According to self-determination theory, when preservice teachers have clear goals and values in life, they can deeply understand and recognize their roles and responsibilities as teachers, which grants them the motivation to persevere in the face of difficulties and challenges (Xie & Xiong, 2014). In this way, they continue to try, explore, and practice with the goal of improving their professional quality and abilities. Therefore, we believe

that career calling can mediate the effect of meaning in life on innovative behavior. However, research on this topic remains lacking. It is necessary to empirically test the relationships among career calling, meaning in life, and innovative behavior. Based on the preceding analysis, we propose the following research hypothesis.

H2 Career calling mediates the relationship between meaning in life and innovative behavior.

The mediating role of learning engagement

Learning engagement refers to students' tendency to exhibit a continuously positive emotional state during the course of learning activities; this state is characterized by vitality, dedication, and concentration (Schaufeli et al., 2002). As the source of future teachers, preservice teachers' learning engagement during their college years is essential for skilled professional growth and is related to the quality of the teaching workforce (Yuan et al., 2022). Learning engagement is a prerequisite for students' ability to gain expertise, enhance their professional competence, and promote their professional development (Chen et al., 2016). Domain-related expertise, creative skills, and task motivation are three elements that affect innovative behavior (Huang et al., 2019). According to the creative action model, knowledge and competence in a particular domain are significant drivers of individual innovative behavior (Huang et al., 2019). This notion implies that innovation is a process that is driven by continuous learning (Xu & Suntrayuth, 2022), emphasizing the necessity of increased learning engagement for students' innovative behaviors.

The presence of meaning in life, which functions as an internal cognitive resource, facilitates a deeper comprehension and appreciation of the importance of learning and work within the given context. Furthermore, meaning in life encourages individuals to clarify their learning goals, fosters curiosity, and promotes students' learning engagement (Chen, 2021). According to self-determination theory, college students who possess a stronger sense of meaning in life possess the constructive and self-fulfilling ability to actively pursue self-actualization. Moreover, these individuals exhibit higher levels of personal initiative, thus facilitating the enhancement of their intrinsic motivation for acquiring knowledge, fostering an increased inclination toward learning, and cultivating greater enthusiasm for and engagement in the learning process (Chen et al., 2016). College students who can comprehensively experience meaning in life or who have a cheerful perspective on life are more likely to be motivated to learn due to their curiosity. They are interested in understanding and exploring the

unknown world that surrounds them and thus engage in positive learning behaviors even under high-pressure learning conditions (Zhao et al., 2016b). After reviewing previous studies, we believe that learning engagement serves as a mediator in the relationship between meaning in life and innovative behavior. However, research on the mechanism that links meaning in life, learning engagement, and innovative behavior in the context of preservice teacher education remains lacking. Therefore, empirical studies are needed to confirm the mediating effect of learning engagement on the relationship between meaning in life and innovative behavior. Based on the preceding analysis, we propose the following hypothesis.

H3 Learning engagement mediates the relationship between meaning in life and innovative behavior.

The chain mediating effects of career calling and learning engagement

There is a meaningful relationship between career calling and learning engagement. According to identity theory, individuals with a strong career calling exhibit higher levels of work engagement and take an initiative-driven approach to their work (Huang et al., 2019). As an individual's perception of career calling intensifies, he or she is more likely to exhibit proactive work attitudes, assume greater responsibility, be willing to make sacrifices, and invest more in his or her professional endeavors (Hirschi & Herrmann, 2013). Career calling can cause individuals to become more inclined to view work as an integral part of their lives rather than merely as a task. It increases individuals' enthusiasm and commitment toward their work (Hirschi, 2012) and enhances their internal motivation for work (Liu et al., 2021a), resulting in greater innovative behaviors (Liu et al., 2021b).

According to Martin's (2007) theory of motivation and engagement wheel (MEW), individuals with a stronger career calling exhibit increased internal motivation, which leads to greater engagement in both learning and work. Research on prevocational education has found a significant positive relationship between career calling and readiness for prevocational learning (Hirschi & Herrmann, 2012). Individuals who exhibit a career calling may have higher expectations of their future success, thereby enhancing their level of engagement in academic pursuits during their university years (Shang et al., 2022). Empirical research has suggested that the career calling of preservice teachers positively predicts their learning engagement and that individuals with a stronger career calling are more engaged in learning (Chen et al., 2016). Hirschi (2012) found that career

calling leads employees to invest more energy in their work and to focus more on productivity and job achievement. According to motivation-work matching theory, individuals who are deeply committed to their work and not distracted by external factors are more likely to generate creative ideas and engage in innovative behaviors (Amabile, 1993). According to self-determination theory, intrinsic learning motivation is the most dynamic and persistent motivation that can stimulate individuals' potential and promote their continuous learning and innovation. Career calling is a typical form of intrinsic learning motivation that can ignite individuals' enthusiasm and commitment toward work, thereby fostering their continuous innovation. Based on the preceding analysis, we propose the following hypothesis.

H4 Meaning in life can positively predict innovative behavior through the chain mediating effect of career calling and learning engagement.

Current study

Building on the preceding discussion, this study presents the research model depicted in Fig. 1 to facilitate an investigation of the correlation between meaning in life and innovative behavior. In addition, this paper explores the independent and chain mediating effects of occupational calling and learning engagement on the relationship between life meaning and innovative behavior.

Grade, age, gender, and place of origin were included as control variables

Çinar and Toker (2019) revealed that among 451 health science faculty students, female participants exhibited more innovative behavior than did their male counterparts. Additionally, students from rural areas exhibited lower levels of innovation. Moreover, freshmen scored significantly higher in the dimensions of experiential openness and opinion leadership than did students in other grades. Another study conducted by Jiang et al. (2023), which involved 10,583 nursing students, revealed that age, gender, and place of origin were

significant factors influencing career calling. Other research findings have suggested that age impacts both innovative behavior (Wu et al., 2014; Zhao et al., 2016a) and learning engagement (Zhang et al., 2019). Gender is also a crucial factor affecting learning engagement (Zhang et al., 2019). Studies have shown that male students tend to obtain higher learning engagement scores than female students (Tan et al., 2021). However, contrasting studies have shown that girls' engagement in learning behavior (Kobicheva, 2022; Bru et al., 2021) and emotional engagement (Kobicheva, 2022) are significantly greater than those of male students. Reker (2005) discovered that young women tend to report greater levels of meaning in life than men. Based on this analysis, we believe that variables such as meaning in life, innovative behavior, learning engagement, and career calling are affected by gender, grade level, place of origin, and age. Therefore, when testing the hypothesized theoretical model proposed in this study, we controlled for grade, age, gender, and place of origin.

Method

Participants and procedure

This study was approved by the Ethics Committee of Zhaoqing University (IRB NO. ZQU112). We employed self-assessment questionnaires to collect the research data. Before starting the questionnaire, participants were given a detailed explanation of the aims of this study and were informed that the collected data would be used only for academic research purposes. The choice to complete or withdraw from this study was completely voluntary for all participants.

The researcher distributed an electronic questionnaire to preservice teachers with the support of their classroom teachers. Participants were provided with clear instructions that they were asked to read before responding to the questionnaire. A total of 2,634 responses were collected from five universities located in three provinces. Among these responses, 2,516 were considered to be valid, as indicated in Table 1. The exclusion of 118 responses was necessary

Fig. 1 Hypothesized theoretical model

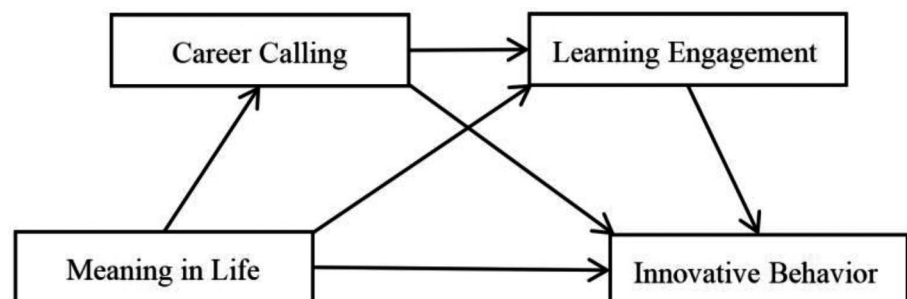


Table 1 Demographic information of the participants ($n = 2516$)

Basic Data	Item	Amount (%)
Gender	Male	1,097 (43.60%)
	Female	1,419 (56.40%)
Grade	Freshman	955 (37.96%)
	Sophomore	701 (27.86%)
	Junior	560 (22.26%)
	Senior	300 (11.92%)
Place of origin	Rural	931 (37.00%)
	Township	673 (26.75%)
	City	912 (36.25%)

due to incorrect responses to the polygraph question “Please select ‘completely disagree’ for this question”, resulting in a valid questionnaire rate of 95.52%.

Measures

Innovative behavior

We modified the innovative behavior scale developed by Zhang et al. (2016) to better suit the context of college students. For instance, we revised the seventh question in the original scale from “I often recommend the implementation of new working methods to my colleagues” to “I frequently introduce new learning or working methods to my classmates.” The scale includes eight items and is scored on a 5-point Likert scale, with 1 indicating “strongly disagree” and 5 representing “strongly agree”. The scoring method used for this scale is based on the total score of all items. A higher score shows that the individual engages in more innovative behavior. A confirmatory factor analysis (CFA) of our study sample revealed that the Innovative Behavior Scale exhibited good fit indices, i.e., $\chi^2/df = 4.427$, CFI = 0.995, TLI = 0.988, RMSEA = 0.037, and the factor loadings ranged from 0.59 to 0.74. In our study, the Cronbach’s alpha coefficient for this scale was 0.88.

Learning engagement

The present study employed the revised Learning Engagement Scale developed by Fang et al. (2018), which includes 17 items that are used to assess three dimensions: vitality, dedication, and concentration. An example item is “I enjoy studying immediately after waking up in the morning.” A 7-point Likert scale ranging from “1 = never” to “7 = always/every day” was used for this measure, with higher scores showing a greater level of dedication to learning. The internal consistency of this scale, as measured by Cronbach’s alpha coefficient, was 0.94 in the present study.

Career calling

The Career Calling Scale, which was developed by Zhang (2015), was employed in this study. The scale contains 11 items across three dimensions: altruistic contribution, orientation, meaning and value. Responses were scored on a 5-point scale ranging from “1 = strongly disagree” to “5 = strongly agree”. An example item from the scale is “I aspire to pursue a career that can benefit others.” The internal consistency of the scale, as measured by Cronbach’s alpha coefficient, was 0.81 in this study.

Meaning in life

In this research, the perceived dimension of meaning in life was assessed using the Chinese version of the Meaning in Life Scale (C-MLQ), which was revised by Wang and Dai (2008). This scale comprises five items, which were scored on a 7-point Likert scale ranging from “1 = strongly disagree” to “7 = strongly agree”. One of the items included in the scale was “I aspire to pursue a career that can benefit others.” Higher scores on the scale indicate a greater level of meaning in life. The internal consistency of this scale, as measured by Cronbach’s alpha coefficient, was 0.87 in this study.

Data analysis

The data used in this study were analyzed using SPSS and AMOS software. To ensure consistency in the scoring scales, we applied the formula “ $Y = (B-A) * (x-a) / (B-A) + A$ ” (IBM, 2020) to convert participants’ scores on both the Learning Engagement Scale and the Meaning in Life scale from a 7-level rating system to a 5-level rating system. Confirmatory factor analysis was conducted using AMOS, and goodness-of-fit was evaluated using the criteria recommended by Schumacker and Lomax (2004), including $\chi^2/df \leq 5$, RMSEA ≤ 0.08 , CFI ≥ 0.90 , and TLI ≥ 0.90 . The statistical analyses, including the tests for common method bias, difference tests, and correlation analyses, were conducted using SPSS. Additionally, PROCESS was used to perform chain mediation analysis.

Results

Common method bias test

The data collection method employed in this study involved self-reports, which have the potential to introduce systematic errors (Zhou & Long, 2004). To ensure the scientific rigor of the study’s findings, Harman’s single-factor test

Table 2 Results of the correlation analysis

	M	SD	1	2	3
1 Innovative behavior	27.03	6.40			
2 Career calling	38.56	7.39	0.61***		
3 Learning engagement	49.63	11.63	0.55***	0.66***	
4 Meaning in life	14.39	3.43	0.31***	0.40***	0.39***

Note *** $p < 0.001$

was conducted to assess the presence of common method bias prior to the formal data analysis (Harman, 1976). The results of Harman’s single-factor test showed that the characteristic root of five factors was greater than one and that the variance contribution of the first factor was 34.31% (less than 40%), thus indicating the absence of significant common method bias in the study.

Difference tests and correlation analysis

The results of the difference tests showed that place of origin had a significant effect on participants’ innovative behavior ($F=2.847, p=0.058$) and career calling scores ($F=4.596, p=0.01$). Furthermore, gender was found to have a significant impact on participants’ innovative behavior ($t=-2.194, p=0.028$) and career calling scores ($t=-2.819, p=0.005$). Additionally, grade was shown to significantly affect participants’ innovative behavior ($F=3.867, p=0.009$), career calling ($F=3.337, p=0.019$), and learning engagement scores ($F=6.235, p<0.001$). The results of the correlation analysis showed that age was significantly and positively correlated with learning engagement ($r=0.08, p<0.001$) and innovative behavior ($r=0.04, p=0.03$). Therefore,

grade, age, gender, and place of origin were included as control variables in the model test.

The foundation of model testing is predicated on the correlations among the primary variables. As a result, we conducted a bivariate correlation analysis to scrutinize the interconnections among these variables. The findings, which are presented in Table 2, revealed positive correlations among learning engagement, innovative behavior, career calling, and meaning in life. Consequently, additional research is needed to determine the associations among innovative behavior, meaning in life, learning engagement, and career calling.

Mediating effect test

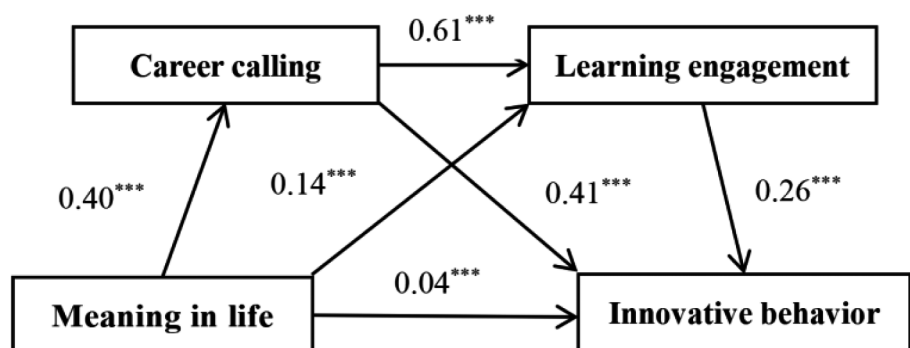
After controlling for age, gender, grade, and place of origin, the mediating effects were tested using Model 6 in the SPSS PROCESS macro with 5000 repeated samples. As presented in Table 3, meaning in life positively predicted innovative behavior in the absence of mediating variables ($\beta=0.31, t=16.09, 95\% \text{ CI} = [0.27, 0.34]$), thereby confirming H1. The results of the mediating effect analysis (see Table 3; Fig. 2) showed that meaning in life positively predicted career calling ($\beta=0.40, t=21.62, 95\% \text{ CI} = [0.36, 0.43]$), learning engagement ($\beta=0.14, t=8.81, 95\% \text{ CI} = [0.11, 0.17]$) and innovative behavior ($\beta=0.04, t=2.52, 95\% \text{ CI} = [0.01, 0.08]$) and that career calling positively predicted learning engagement ($\beta=0.61, t=38.74, 95\% \text{ CI} = [0.58, 0.65]$) and innovative behavior ($\beta=0.38, t=18.29, 95\% \text{ CI} = [0.34, 0.42]$). Additionally, learning engagement

Table 3 Results regarding the chain mediating model

Result variables	Predictive variables	R	R ²	F	β	t	95% CI
Innovative behavior	Meaning in life	0.31	0.10	54.17***	0.31	16.09***	[0.27,0.34]
Career calling	Meaning in life	0.40	0.16	96.56***	0.40	21.62***	[0.36,0.43]
Learning engagement	Meaning in life	0.69	0.47	370.65***	0.14	8.81***	[0.11,0.17]
	Career calling				0.61	38.74***	[0.58,0.65]
Innovative behavior	Meaning in life	0.64	0.41	246.60***	0.04	2.52*	[0.01,0.08]
	Career calling				0.41	19.54***	[0.37,0.46]
	Learning engagement				0.26	12.20***	[0.22,0.30]

Note Coefficients are standardized; bootstrap samples = 5,000; CI = confidence interval; * $p < 0.05$, *** $p < 0.001$

Fig. 2 Results regarding the chain mediating effect



positively predicted innovative behavior ($\beta=0.26, t=12.20, 95\% \text{ CI} = [0.22, 0.30]$).

As presented in Table 4, Path 1 had a significant effect (effect=0.164, SE=0.01, 95% CI = [0.14, 0.19]), with an effect ratio of 53.77%, thereby confirming H2. Similarly, Path 2 had a significant effect (effect=0.036, SE=0.01, 95% CI = [0.02, 0.05]), with an effect ratio of 11.80%, thereby confirming H3. Path 3 also had a significant effect (effect=0.063, SE=0.01, 95% CI = [0.05, 0.08]), with an effect ratio of 20.66%, thereby confirming H4. Furthermore, the total indirect effect was calculated to be 0.26, accounting for 86.23% of the total effect.

Discussion

In this study, a chain mediation model was constructed to analyze the relationship between preservice teachers' meaning in life and innovative behavior, in which career calling and learning engagement were identified as mediating variables. The results indicated that (1) meaning in life positively predicts innovative behavior; (2) career calling significantly mediates the relationship between meaning in life and innovative behavior; (3) learning engagement significantly mediates the relationship between meaning in life and innovative behavior; and (4) career calling and learning engagement have a significant chain mediating effect on the relationship between meaning in life and innovative behavior. Therefore, enhancing preservice teachers' meaning in life, career calling, and learning engagement can stimulate their innovative behavior. These findings can expand our understanding of the factors influencing innovative behavior.

The relationship between meaning in life and innovative behavior

The results of the study showed that meaning in life positively predicts innovative behavior, thus verifying Hypothesis 1. The findings confirmed the direct relationship between meaning in life and innovative behavior. The university stage is a critical stage for the pursuit and discovery of meaning in life (Hee & Sunghyun, 2017). For preservice teachers, striving to discover and experience meaning and value in life can help them look forward to their future lives and be more aware of the importance of improving their innovation skills as teachers in the future. According to self-determination theory, the meaning of life, as an inner belief, is an important psychological resource that can help preservice teachers engage in innovative behavior. Preservice teachers who experience more meaning in life are more likely to perceive positive elements of their environment and to acquire more cognitive resources and mental strength through their continuous and efficient interactions with their surroundings (Zhang & Li, 2018), thus providing them with a constant source of internal motivation and external support for innovative behaviors.

The mediating roles of career calling and learning engagement

The results of the study showed that the mediating effect of career calling on the relationship between meaning in life and innovative behavior was significant, thus verifying Hypothesis 2. Furthermore, the mediating effect of the path "life meaning → career calling → innovative behavior" accounted for 53.77% of the total effect, thereby indicating that it is an important pathway for promoting innovative behavior among preservice teachers. The findings of this study confirmed the positive predictive effect of meaning in

Table 4 Decomposition of the intermediary effect, direct effect, and total effect

Effect type	Paths	Effect	Boot SE	Boot LLCI	Boot ULCI	Effect percentage (%)
Total effect	Meaning in life → Innovative behavior	0.305	0.02	0.27	0.34	
Direct effect	Meaning in life → Innovative behavior	0.043	0.02	0.01	0.08	14.10
Indirect effects	Total indirect effect	0.263	0.02	0.23	0.29	86.23
	Path 1: Meaning in life → Career calling → Innovative behavior	0.164	0.01	0.14	0.19	53.77
	Path 2: Meaning in life → Learning engagement → Innovative behavior	0.036	0.01	0.02	0.05	11.80
	Path 3: Meaning in life → Career calling → Learning engagement → Innovative behavior	0.063	0.01	0.05	0.08	20.66

Note Coefficients are standardized; bootstrap samples = 5,000; Boot LLCI: bootstrapping lower limit confidence interval; Boot ULCI: bootstrapping upper limit confidence interval

life on career calling (Duffy et al., 2014) as a prerequisite for career calling (Zhang et al., 2017). The findings also confirmed that career calling is an important factor influencing innovative behavior. When preservice teachers know what makes their lives meaningful, they may be more willing to discover meaning in different areas of their lives, such as their career calling as a teacher (Zhang et al., 2017). Moreover, preservice teachers who can perceive meaning in life exhibit clearer self-concepts (Li et al., 2021), and such clear self-concepts serve as the foundation for their ability to discover their career calling (Hall & Chandler, 2005). Moreover, preservice teachers with a strong career calling tend to engage in altruistic and pro-social behaviors (Yao et al., 2020), which makes them more popular among their peers, provides them with more opportunities for communication and interaction with their peers, promotes knowledge sharing among groups of preservice teachers, and thus inspires preservice teachers to engage in more innovative behaviors.

The study's findings showed that learning engagement significantly mediates the relationship between meaning in life and innovative behavior, accounting for 11.80% of the total effect, thereby confirming Hypothesis 3. Preservice teachers' meaning in life can increase their innovative behavior by enhancing their learning engagement. Preservice teachers with a strong meaning in life can experience more positive emotions in the context of learning and attach greater value to learning activities in the present moment, thereby increasing their level of learning engagement. The greater the physical and psychological involvement of preservice teachers in academics, the better their learning outcomes and competency development, which can help enhance preservice teachers' critical thinking and promote their innovative behaviors (Yang et al., 2019). Furthermore, investing more time and effort in learning can help individuals identify innovative points and challenges that must be overcome, find effective solutions to these challenges, and promote the transformation of innovation abilities into actual behaviors (Yuan et al., 2022).

The findings of the study highlight the significant chain mediating effect of career calling and learning engagement on the relationship between meaning in life and innovative behavior. This effect accounts for 20.66% of the total effect, thereby supporting Hypothesis 4. These results suggest that individuals with a stronger career calling are more likely to engage in learning related to their career, which is in line with the results of previous earlier research (Yuan et al., 2022; Chen et al., 2016). A career calling involves a deep understanding of one's own career, which can stimulate the intrinsic motivation of preservice teachers and increase their willingness to devote their time and energy to learning (Martin, 2007). When preservice teachers have a strong career calling, they view learning as an important way of

achieving their own values and goals rather than as a simple task or responsibility (Wan, 2011). A strong career calling causes preservice teachers to be more focused on their studies and work, improves their ability to resist external interference and temptation, and enables them to view learning as enjoyable rather than burdensome, thus improving efficiency (Yuan et al., 2022).

Implications

Theoretical implications

This study uses the framework of self-determination theory to investigate the impact of meaning in life on innovative behavior with the aim of comprehensively understanding and acknowledging the role of intrinsic motivational factors in driving innovative behavior. The results confirm the applicability of self-determination theory in innovation research. Additionally, we incorporate meaning in life, career calling, learning engagement, and innovative behavior into one research model and discover that meaning in life can directly affect innovative behavior while simultaneously having an indirect effect on innovative behavior through career calling and learning engagement. These findings broaden our understanding of the relationships among meaning in life, career calling, learning engagement, and innovative behavior, thereby providing researchers with additional perspectives that can enrich future investigations.

Practical implications

This study provides valuable insights into the impacts of meaning in life, career calling, and learning engagement on the innovative behavior of preservice teachers. By analyzing the effect mechanism of these factors, this research offers guidance for the design and implementation of innovation education. According to the results of this research, to stimulate preservice teachers' innovative behavior and improve their ability, we can offer various educational practice opportunities that can enable preservice teachers to experience and participate in meaningful educational activities that can enhance their meaning in life. Furthermore, offering guidance for professional development is crucial with regard to enhancing preservice teachers' professional aptitude, reputation, and vocational aspirations by clarifying their career goals and calling. Additionally, providing superior education and training programs is essential, as they foster increased engagement in learning while continuously enhancing preservice teachers' pedagogical abilities and knowledge.

Limitations and directions for future research

This study has several limitations. First, the cross-sectional design of this study prevents us from determining the causal relationships among the variables. Therefore, future studies could employ experimental methods to enhance the persuasiveness of these findings. Second, both the independent mediating effect and the chain mediating effect revealed by the present study are partial mediating effects, thus implying that other intrinsic mechanisms might affect the relationship between preservice teachers' meaning in life and innovative behaviors, which would require further exploration in future studies. Third, the literature has suggested that both positive and negative variables should be considered when mediating effects are examined (Liu & Xu, 2022), thus highlighting the potential for investigating other mediating variables based on this perspective in future research. Finally, it is important to note that all participants in this study were of Chinese cultural background. It should be acknowledged that individuals from diverse cultural backgrounds may possess distinct interpretations regarding the meaning in life, potentially exerting varying influences on innovative behavior. Future research could explore cross-cultural disparities pertaining to the relationship between the meaning in life and innovative behavior.

Conclusions

The innovation ability of preservice teachers has a direct impact on the educational quality of future generations. However, nonintellectual factors that affect innovation ability are often neglected in training aimed at improving preservice teachers' innovation ability, a situation which hampers the desired training outcomes. To investigate this phenomenon further, we selected meaning in life as an important nonintellectual factor and conducted a survey of preservice teachers using a questionnaire that consisted of four sections: meaning in life, career calling, learning engagement, and innovative behavior. The results indicate that meaning in life significantly affects innovative behavior through the independent mediating effects of career calling and learning engagement. Additionally, meaning in life can also exert its effect through the chain mediating effect of career calling and learning engagement. This finding implies that preservice teachers' meaning in life not only directly impacts their innovative behavior but also enhances it by enhancing their career calling and learning engagement. Therefore, future research should consider both intellectual and nonintellectual factors when exploring innovative behavior. Furthermore, teacher training institutions should pay attention to

nonintellectual factors such as enhancing preservice teachers' meaning in life, career calling and learning engagement to cultivate their innovation abilities more effectively.

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Data availability The researcher will require ongoing access to the data for further studies. Therefore, if any other researchers express interest in this study or require related data, they may submit requests to the corresponding author via email at huangweiwei@zqu.edu.cn.

Declarations

Ethics approval and consent to participate This study was approved by the Ethics Committee of Zhaoqing University (IRB NO. ZQU112). The purpose of the study was clearly communicated to the participants and was conducted with their informed consent.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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