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How self-efficacy shapes professional identity: the mediating role of meaning in life and self-esteem in pre-service physical education teachers

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Abstract

Background Professional identity is a crucial psychological construct that shapes pre-service physical education (PE) teachers' academic engagement, persistence, and future career commitment. However, limited research has examined the psychological mechanisms that foster the development of professional identity in this population. This study explores how self-efficacy contributes to the formation of professional identity among PE pre-service teachers, with a particular focus on the mediating roles of meaning in life and self-esteem.

Method A cross-sectional study was conducted with 465 PE pre-service teachers. Data on self-efficacy, meaning in life, self-esteem, and professional identity were collected through validated self-report questionnaires. Structural equation modeling was used to analyze the direct and indirect effects of self-efficacy on professional identity and to test the mediating roles of meaning in life and self-esteem.

Results The findings revealed that self-efficacy was positively associated with professional identity. Additionally, meaning in life and self-esteem were found to mediate this relationship. Specifically, self-efficacy was linked to higher levels of professional identity through both independent mediating effects of meaning in life and self-esteem and a chain mediation effect involving both variables. These findings provide insights into the psychological mechanisms underlying the development of professional identity among pre-service PE teachers.

Conclusion The findings highlight the psychological pathways through which self-efficacy shapes professional identity in pre-service PE teachers. Enhancing teacher training programs to foster self-efficacy, promote a sense of meaning, and strengthen self-esteem may be critical for developing a stable and positive professional identity. These insights provide practical implications for improving teacher education and reducing attrition in the field of physical education.

Keywords Self-efficacy, Professional identity, Meaning in life, Self-esteem, Pre-service PE teachers

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Introduction

In recent years, there has been growing scholarly interest in understanding how teachers construct their professional identity, particularly during the pre-service phase of teacher education. As teacher shortages and early-career attrition continue to pose global challenges, it is critical to investigate not only what professional identity is, but also how it forms and can be supported during teacher preparation.

Professional identity refers to an individual's understanding, perception, and sense of belonging to their chosen professional role. It reflects one's professional values, beliefs, and emotional commitment to teaching [1]. This construct has been widely recognized as a key factor influencing teacher quality and retention. The formation of professional identity is influenced by personal experiences, social interactions, and cultural contexts, making it a complex and multidimensional psychological process. Research suggests that professional identity affects teachers' emotions, cognition, and behavioral tendencies [2]. Moreover, it directly impacts their teaching practices, career development, and attitudes toward educational reforms [3, 4]. Teachers with a strong professional identity tend to exhibit greater professional commitment and enthusiasm, enabling them to manage occupational stress and challenges more effectively [5]. Additionally, a well-developed professional identity positively influences students' academic performance [6]. Thus, examining the formation of professional identity has both theoretical and practical relevance for education systems worldwide.

Although existing research has explored teacher professional identity from multiple perspectives, most studies have focused on in-service teachers, particularly those in general academic subjects [7–11]. In contrast, pre-service PE teachers remain an under-researched group, despite encountering unique challenges in identity formation. Pre-service PE teachers face unique challenges in forming their professional identity, including the marginalization of PE within the education system, the undervaluation of PE teachers' professional roles, and limited career development opportunities [12, 13]. These factors may weaken their sense of professional belonging and, consequently, impact their long-term career development. However, few studies have examined the specific pathways and key factors influencing the professional identity formation of pre-service PE teachers. Furthermore, existing studies have primarily focused on external influences on professional identity, such as school environments and social support [14, 15], or have analyzed its key components [11]. Limited attention has been given to the underlying psychological mechanisms that contribute to professional identity development. While some studies have investigated the effects of self-efficacy, meaning in life, and self-esteem on individual development [16–18],

there is a growing recognition that these psychological resources are interrelated and may act together to influence identity formation.

Recent research emphasizes the role of cognitive-affective variables in shaping pre-service teachers' professional dispositions. For instance, Orakcı et al. [19] found that self-efficacy significantly mediates the relationship between cognitive flexibility and critical thinking disposition, suggesting that self-efficacy not only facilitates adaptive learning but also promotes the internalization of professional goals. Another study further demonstrated that self-efficacy enhances individuals' perceived control over complex situations, thereby directly promoting the development of creative thinking, which is closely linked to critical thinking disposition [20]. These findings highlight the need to further investigate how self-efficacy functions within broader motivational and identity-related frameworks. Against this backdrop, a critical problem remains insufficiently addressed: how do internal psychological mechanisms—specifically self-efficacy, meaning in life, and self-esteem—interact to shape the professional identity of pre-service PE teachers, especially in the context of a marginalized discipline? Against this backdrop, a critical research problem emerges: while existing studies acknowledge the importance of self-efficacy and related psychological factors, how these variables interact to shape the professional identity of pre-service PE teachers remains underexplored—particularly in the context of a marginalized discipline.

Grounded in Self-Determination Theory (SDT), this study explores the mechanisms through which self-efficacy, meaning in life, and self-esteem influence the professional identity of pre-service PE teachers. Self-efficacy reflects an individual's belief in their own abilities and is closely associated with the development of professional identity [21]. However, professional identity extends beyond a mere perception and understanding of PE education; it is a multidimensional construct encompassing a sense of belonging, role identity, and career expectations. Meaning in life and self-esteem are central constructs in motivational and well-being research, and may serve as mechanisms by which self-efficacy contributes to stable professional commitment. Thus, this study seeks to clarify how self-efficacy indirectly influences professional identity through meaning in life and self-esteem, rather than treating it as a direct measure of professional identity. By examining the underlying psychological mechanisms, this study emphasizes the role of intrinsic motivation in the development of professional identity. A theoretical model incorporating a chain mediation effect is constructed to test the relationships among self-efficacy, meaning in life, self-esteem, and professional identity.

The primary objectives of this study are to examine the influence of self-efficacy on the professional identity of pre-service PE teachers, explore the mediating roles of meaning in life and self-esteem, and provide theoretical support for teacher educators. Additionally, this study aims to offer empirical evidence to enhance the professional identity of pre-service PE teachers and support their career development. By focusing on internal psychological strengths, this study enriches the theoretical framework of professional identity and contributes to broader efforts aimed at improving teacher education, especially within underrepresented disciplines like PE. Through empirical analysis, it aims to uncover the mechanisms by which self-efficacy, meaning in life, and self-esteem contribute to professional identity, providing practical insights for teacher education programs and professional training. Furthermore, this study underscores the importance of professional identity in teacher career development, offering policy recommendations and educational interventions to strengthen the professional belonging of pre-service PE teachers. Moreover, while the findings are particularly relevant to pre-service PE teachers, they may also have broader implications for teacher education in other subject areas. Future research should examine whether these relationships hold across different disciplines and cultural contexts, further validating the generalizability of the proposed framework.

Literature review

The theoretical framework

SDT posits that an individual's behavior is influenced not only by external factors but also by intrinsic motivation [22, 23]. SDT highlights three fundamental psychological needs—competence, relatedness, and autonomy—as essential drivers of intrinsic motivation, effective behavior, and personal development [24]. When these psychological needs are fulfilled, individuals are more likely to develop sustained intrinsic motivation, which in turn enhances their career adaptability and long-term professional growth. In the development of teachers' professional identity, these three psychological needs interact to shape teachers' perceptions of and sense of belonging to their professional roles [25]. A strong sense of competence enhances confidence in one's ability to fulfill professional responsibilities, relatedness fosters a sense of connection with the teaching community, and autonomy supports self-directed professional engagement. Together, these needs contribute to the development and reinforcement of teachers' professional identity.

This study adopts SDT as a framework to explore the mechanisms through which self-efficacy, meaning in life, and self-esteem contribute to the professional identity of pre-service PE teachers. Previous research has indicated that self-efficacy, as an individual's belief in their own

abilities, is closely linked to competence and may shape perceptions of and attitudes toward professional roles [26]. Among pre-service PE teachers, individuals with higher self-efficacy tend to exhibit greater confidence, which may translate into a stronger sense of professional identity in teaching practice. However, this relationship is unlikely to be direct and may be influenced by other psychological factors.

Meaning in life, defined as an individual's recognition of their life goals and values, is closely related to relatedness and may play a crucial role in the development of professional identity. When pre-service PE teachers perceive their career goals as meaningful, they may experience a stronger sense of professional belonging and greater commitment to their professional development. Prior studies suggest that meaning in life provides individuals with psychological stability and may influence their professional attitudes [27]. Therefore, meaning in life may serve as an intermediary between self-efficacy and professional identity, reinforcing an individual's commitment to their professional trajectory.

Similarly, self-esteem, which is strongly associated with autonomy, may further shape professional identity. An individual's level of self-esteem is typically influenced by a combination of perceived competence and social recognition. An increase in meaning in life may foster greater self-confidence, which in turn may contribute to higher levels of self-esteem [28]. Research has also indicated that higher self-esteem is linked to a more stable sense of professional identity [29]. Thus, self-esteem may act as a bridge between meaning in life and professional identity, helping individuals positively integrate their professional roles into their self-concept.

Based on these theoretical considerations, this study examines how self-efficacy indirectly relates to professional identity through the sequential effects of meaning in life and self-esteem. By comprehensively analyzing the relationships among these variables, this study seeks to provide theoretical insights and practical implications for supporting the professional development of pre-service PE teachers.

Self-efficacy and professional identity

Self-efficacy refers to an individual's belief in their ability to successfully complete tasks or overcome challenges in a specific context [30]. This belief not only influences behavioral choices but also determines the level of effort invested and emotional responses when facing difficulties [31]. As a core psychological resource, self-efficacy reflects an individual's self-assessment of their future performance, focusing on the perception of ability rather than actual ability levels. Studies have shown that individuals with high self-efficacy tend to demonstrate greater perseverance and optimism when facing challenges,

while those with low self-efficacy are more likely to avoid or give up due to negative emotions, such as anxiety and fear [32]. Additionally, self-efficacy is dynamic, adjusting over time as experiences accumulate and environments change [33].

In the process of forming professional identity, self-efficacy plays a crucial role. A study on inclusive education teachers found that those with higher self-efficacy displayed greater engagement and problem-solving proactivity in their teaching, which, in turn, enhanced their professional identity [34]. Another study demonstrated that the teaching self-efficacy of rural PE teachers, which includes dimensions such as classroom management, student participation, and teaching strategies, significantly predicted their professional identity [35]. These studies suggest that self-efficacy positively influences professional identity by motivating teachers and enhancing their behavioral performance. SDT posits that confidence in task completion is a key component of motivation [36]. Motivation is not only a crucial driver of teacher behavior but also a key factor in the formation of professional identity. Watt and Richardson emphasized the close relationship between self-efficacy and professional behavior [37], while Canrinus et al. demonstrated that self-efficacy is a fundamental condition for the development of professional identity [38]. Professional identity is a dynamic psychological trait that reflects an individual's ongoing recognition and positioning within their profession [1]. Research indicates that individuals with high self-efficacy tend to have stronger career commitment and exhibit greater career value and job satisfaction [39]. For instance, a study on Iranian foreign language teachers found a significant positive correlation between self-efficacy and professional identity [40]. Furthermore, Li et al. also confirmed a mutually reinforcing relationship between professional identity and self-efficacy in a sample of high school students [41]. It should be emphasized that professional identity does not develop rapidly, but rather develops through the ongoing interaction between the individual and the social environment. Ibarra proposed that individuals typically experience a phase of tentative identity before their professional identity is fully established [42]. Longitudinal research by Dobrow and Higgins found that the clarity of professional identity increases over time [43]. In this process, self-efficacy, as a crucial psychological resource, plays an active role in promoting the formation and consolidation of professional identity.

The role of meaning in life in the impact of self-efficacy on professional identity

Meaning in life refers to an individual's perception of the value and significance of life, comprising two core dimensions: the presence of meaning and the search for

meaning. The former reflects the clarity of an individual's life goals and their understanding of their own position, while the latter refers to the intensity and effort invested in the ongoing exploration of life's meaning, often arising from dissatisfaction with the present or a desire for higher significance [44]. Meaning in life is an important indicator of psychological well-being, and individuals with higher meaning in life typically demonstrate greater openness, resilience, and a more positive outlook on life [45]. In contrast, a lack of meaning in life may lead to negative worldviews and confusion in life experiences.

There is a significant positive relationship between self-efficacy and meaning in life. Research has shown that self-efficacy can significantly influence an individual's level of effort and perseverance, making it easier for them to experience a sense of achievement while pursuing goals, thereby enhancing their perception of meaning in life [30]. Individuals with higher self-efficacy typically provide positive guidance for their actions and experience a stronger sense of value and purpose after completing tasks [31]. In educational research, teachers with high self-efficacy tend to believe that their efforts can help students make progress. This belief, particularly when working with students facing learning difficulties, strengthens their sense of meaning in their teaching work [46]. In contrast, teachers with low self-efficacy may feel powerless, which diminishes their perception of meaning in life. Furthermore, self-efficacy enhances an individual's initiative and sense of purpose, enabling them to better cope with challenges in life. This ability drives individuals to maintain enthusiasm and goal-oriented motivation in complex environments, thereby strengthening their sense of meaning in life [33]. Therefore, self-efficacy not only plays a role in task completion but also enhances meaning in life, improving individuals' life experiences and psychological well-being.

Meaning in life is a significant predictor of professional identity, especially in terms of an individual's understanding of the value and goals of their profession. Individuals with high meaning in life are more likely to align their personal life goals with their professional objectives, thereby finding a sense of direction and belonging in their careers [47]. Studies show that individuals with high meaning in life not only demonstrate greater interest and engagement in their professional tasks but also exhibit stronger psychological resilience and adaptability when facing career challenges [45]. These positive emotional experiences and proactive behaviors further promote the development of professional identity. According to SDT, meaning in life fulfills basic psychological needs such as autonomy, competence, and relatedness, and the satisfaction of these needs is crucial for the formation of professional identity [36]. Specifically, individuals with high meaning in life are more likely to adopt positive

future-oriented strategies, strive to achieve professional goals, and experience a sense of accomplishment and pride in their professional activities. These emotional experiences further strengthen their identification with their professional identity, leading to greater investment in career development [39]. Additionally, meaning in life promotes professional identity by enhancing individuals' positive evaluation of their professional role and understanding of its significance. For example, individuals with high meaning in life are more likely to perceive their profession as important to society, making them more willing to embrace the difficulties and challenges within their careers. This attitude helps individuals maintain a positive outlook in complex professional environments, further reinforcing their sense of value and belonging within their profession.

The role of self-esteem in the impact of self-efficacy on professional identity

Self-efficacy and self-esteem are key components of self-assessment. They can serve as indicators of performance in specific tasks or as general traits of the individual. Although conceptually distinct—self-efficacy primarily concerns an individual's belief in their ability to accomplish specific tasks, while self-esteem focuses on an individual's emotional evaluation of their self-worth—research has shown that there is a significant correlation between the two [48]. As a belief in future behavioral success, self-efficacy can significantly predict an individual's level of self-esteem and intrinsic sense of value [49]. Self-esteem refers to an individual's overall evaluation of their worthiness to be loved, respected, and successful, expressed through their perception of their own abilities, value, and significance. Individuals with high self-esteem tend to engage in positive self-evaluations, perceiving themselves as valuable and accepted, whereas those with low self-esteem often have negative self-perceptions, even feeling worthless [50]. Self-esteem is not only an emotional experience but also a psychological resource that promotes positive individual development. Studies have shown that an increase in self-efficacy significantly boosts self-esteem, with successful experiences reinforcing an individual's recognition of their abilities [51]. Among teachers, teaching self-efficacy significantly influences their level of self-esteem. Teachers with higher self-efficacy typically have more confidence in helping students overcome learning difficulties, and this confidence translates into a sense of accomplishment and self-worth [46]. Research has found that individuals with high self-efficacy often exhibit higher levels of self-esteem when facing career challenges, a correlation that is especially notable among pre-service teachers and teachers [29, 52]. Thus, self-efficacy not only serves as a prerequisite for healthy self-esteem but also helps individuals

develop a positive self-image by strengthening their belief in success and their ability to take action [53].

Self-esteem is closely related to professional identity. Individuals with high self-esteem are more likely to find meaning and a sense of belonging in their careers, and this positive self-perception helps in the formation and consolidation of professional identity. Studies have shown that high self-esteem not only enables individuals to cope more actively with career challenges and stress but also strengthens their sense of professional belonging [54]. Self-esteem promotes professional identity by enhancing emotional experiences and psychological security. Individuals with high self-esteem typically exhibit stronger social behaviors, autonomy, and adaptability. They not only maintain clarity in their career goals but also improve their self-efficacy and job satisfaction through a positive attitude toward their profession [52]. For example, research on nurses has shown a strong positive correlation between self-esteem and professional identity. Nurses with high self-esteem are more likely to experience a sense of value and purpose in their work, thus enhancing their identification with their professional role [55]. Additionally, self-esteem's impact on professional identity is evident in the acceptance of professional identity. High self-esteem individuals are more likely to view challenges and achievements in a positive light, aligning their career goals with their self-worth, which further strengthens their professional identity. In contrast, individuals with low self-esteem are more vulnerable to setbacks and negative emotions, leading to a more negative attitude toward their professional identity [52].

Meaning in life and self-esteem play a key role in the formation of professional identity. Meaning in life refers to an individual's perception of the value and goals of life, and it is a stable predictor of psychological well-being as well as an important psychological resource for coping with stress and life challenges [56]. When individuals perceive life as having clear meaning and direction, they are more likely to experience positive emotions and form affirmations of their self-worth. This positive psychological experience helps individuals enhance their self-esteem, leading them to view themselves and life's challenges more positively [50]. In contrast, individuals who lack a sense of meaning in life often feel empty and helpless, displaying negative emotions and a pessimistic attitude toward life. Terror Management Theory (TMT) suggests that meaning and the perception of meaning itself form the basis of self-esteem. By perceiving life's meaning, individuals can view their existence more positively, thereby enhancing their self-identity and self-esteem [57]. Self-determination theory further supports this view, proposing that meaning in life promotes intrinsic motivation, facilitates self-actualization, and ultimately boosts self-esteem [36]. Research has shown that

meaning in life is a significant predictor of self-esteem, significantly enhancing an individual's sense of self-worth [56]. For example, a study on university students found that individuals with a higher sense of meaning in life exhibited stronger levels of self-esteem, indicating a tendency to positively evaluate their value and achievements in life [58]. Furthermore, Baumeister proposed that meaning in life stems from the fulfillment of four basic needs: purpose, correctness, efficacy, and self-worth [59]. Among these, efficacy and self-worth are core components of self-esteem, meaning that meaning in life is an important psychological resource for building self-esteem. Research by Halama and Dedova further verified this idea [60], showing that the emotional satisfaction brought by meaning in life not only improves individuals' positive emotions but also enhances their sense of self-worth. When individuals perceive their lives as having clear goals and direction, they are more likely to feel their own value and importance, thereby exhibiting higher levels of self-esteem.

As an individual's belief in their own abilities, self-efficacy not only directly enhances meaning in life but also indirectly influences self-esteem through meaning in life [51]. This indicates that self-efficacy can enhance professional identity by strengthening individuals' perceptions of life goals and meaning, stimulating positive emotional experiences and a sense of self-worth. Research shows that meaning in life helps individuals better integrate the cognitive and emotional components of their professional roles, thereby strengthening professional identity [60]. When individuals perceive their lives as meaningful, they are more likely to project this sense of meaning onto their careers, finding value and belonging in their professional lives. Individuals with high meaning in life demonstrate greater motivation and resilience in their careers and are more likely to experience pride and accomplishment. These positive emotions further reinforce their professional identity [50]. On the other hand, self-esteem, as an individual's comprehensive evaluation of their self-worth, is closely related to professional identity. Individuals with high self-esteem are more likely to accept their professional roles and exhibit more positive attitudes and behaviors toward their careers [54]. The enhancement of self-esteem helps individuals confidently face challenges and stressors in their careers, while also strengthening their job satisfaction and professional identity. The combination of meaning in life and self-esteem provides powerful psychological support for the formation of professional identity.

Based on the above discussion, this study proposes the following hypotheses:

H1: Self-efficacy positively predicts professional identity.

H2: Meaning in life mediates the effect of self-efficacy on professional identity.

H3: Self-esteem mediates the effect of self-efficacy on professional identity.

H4: Self-efficacy is positively associated with professional identity through the chain mediating roles of meaning in life and self-esteem.

Method

Research design

This study targeted government-funded pre-service PE teachers at a specialized sports university in China, selecting undergraduate students majoring in PE education (freshman to senior year) as participants. A stratified cluster sampling design was adopted, consisting of two phases. In the first phase (stratification phase), pre-service PE teachers were categorized into four distinct subgroups based on their academic year (freshman to senior). In the second phase (cluster sampling phase), a random number generator was used to randomly select three intact class groups from each academic year, resulting in a total sample frame of 12 class groups ($N = 603$).

Procedure and sample

The data collection process followed a systematic and standardized procedure to ensure accuracy and reliability. An assessment of the distribution of government-funded pre-service PE teachers at the selected sports university was conducted, and administrators responsible for teacher training were consulted to obtain participant information.

To ensure consistency and efficiency, data collection was conducted entirely online using an anonymous survey via the Questionnaire Star platform. A total of 603 pre-service PE teachers were selected from the university to participate in the questionnaire survey, which was conducted between November 2024 and January 2025. The questionnaire link was distributed by faculty members, and participants completed it within a specified timeframe in a classroom setting, supervised by program administrators to minimize response bias.

Before the survey, instructors explained the study, emphasizing voluntary participation and anonymity. Researchers were available to address any questions. Upon completion, responses were automatically recorded and stored by Questionnaire Star, ensuring data integrity and compliance with ethical research standards. After excluding invalid, duplicate, and logically inconsistent responses, a total of 465 valid questionnaires were obtained, yielding a response rate of 77.11%. Among the valid responses, 342 were male (73.55%) and 123 were female (26.45%). Participants were distributed across four academic years, with 78 first-year students, 167 s-year students, 134 third-year students, and 86 fourth-year

students, and an average age of 19.99 years ($SD = \pm 1.19$). This study was approved and authorized by the Ethics Committee of the participating university, and all participants read and signed the informed consent form before the survey.

Measures

Professional identification scale for normal students (PISNS)

The Professional Identification Scale for Normal Students, developed by Wang et al. [61], was used to measure professional identity in this study. The scale was designed to align with China's national context and policy framework, making it suitable for diverse groups of pre-service teachers. It includes four dimensions: career willingness and expectations, career will, career values, and career efficacy, with a total of 12 items. The scale uses a 5-point Likert rating, where 1 represents "Strongly Disagree" and 5 represents "Strongly Agree." Higher scores indicate a higher level of professional identity. In this study, the Cronbach's α coefficient for the entire scale was 0.907, with Cronbach's α coefficients for the four dimensions being 0.935, 0.836, 0.867, and 0.943, respectively, indicating good internal consistency.

General self-efficacy scale (GSES)

The General Self-Efficacy Scale, developed by Schwarzer [62], was used to measure general self-efficacy and has been validated with good reliability and validity in Chinese college student populations, making it widely applicable [63]. This scale consists of 10 items and uses a 6-point Likert scale, where 1 indicates "Strongly Disagree" and 6 indicates "Strongly Agree." Higher scores indicate a higher level of general self-efficacy. In this study, the Cronbach's α coefficient for the scale was 0.956, indicating excellent internal consistency.

Meaning in life questionnaire (MLQ)

The Meaning in Life Questionnaire, developed by Steger et al. [64] and revised by Liu and Gan [65], was used to assess meaning in life. The scale includes 10 items, covering two dimensions of meaning in life: Presence of Meaning in Life (POM) and Search for Meaning (SFM). The scale uses a 7-point Likert scale, ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). Higher scores indicate stronger meaning in life. In this study, the Cronbach's α coefficient for the scale was 0.915, with Cronbach's α coefficients for the two dimensions being 0.945 and 0.831, respectively, demonstrating good internal consistency.

Self-esteem scale (SES)

The **Self-Esteem Scale**, developed by Rosenberg [66] and revised by Wang et al. [61], was used to assess the participants' self-esteem. The scale consists of 10 items and

uses a 4-point Likert scale, where 1 indicates "Strongly Disagree" and 4 indicates "Strongly Agree." Higher scores indicate a higher level of self-esteem. In this study, the Cronbach's α coefficient for the scale was 0.792, indicating good internal consistency.

Quality control

A pretest was conducted before the formal study to ensure the clarity and comprehensibility of the questionnaire items. The pretest was administered to 10 pre-service physical education teachers and 3 faculty members to assess whether any items contained ambiguous expressions or comprehension difficulties. The feedback indicated that all items were clearly understood by the participants, and no modifications were necessary. Therefore, the questionnaire was deemed suitable for large-scale formal administration.

After data collection, the research team conducted a second screening of the returned questionnaires, excluding those with incomplete information or invalid responses. The valid questionnaire data were entered into statistical analysis software using a double-entry process by two independent individuals to ensure accuracy and reliability of the data entry.

Statistical analysis

Data analysis was conducted using IBM SPSS 26.0 and Mplus 8.3 statistical software. Common method bias was tested using SPSS 26.0 prior to formal data analysis. Correlation analysis was then performed using IBM SPSS 26.0, and latent variable structural equation modeling (SEM) was conducted using Mplus 8.3 to test the hypothesized mediation effects. The number of Bootstrap samples was set to 5000, with the significance level set at $\alpha = 0.05$.

Results

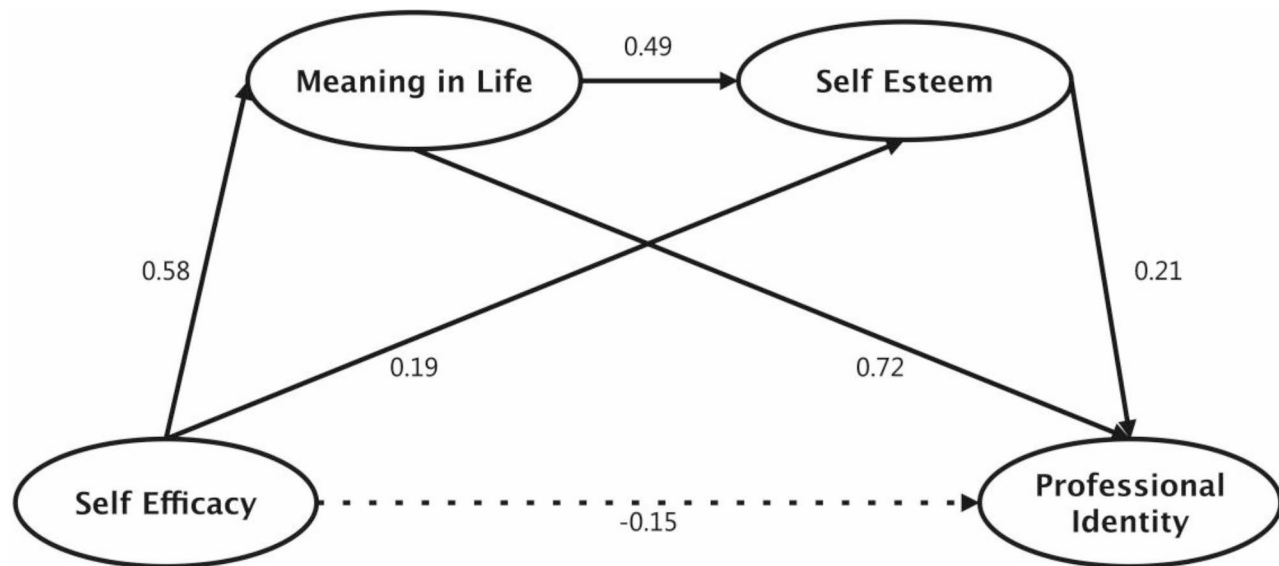
Common method bias test

Since all the variables in this study were measured using self-reports, program and statistical controls were employed to address common method bias. In terms of program control, measures such as anonymous responses, revising ambiguous wording, and providing detailed explanations for potentially confusing statements were implemented to reduce potential bias. Statistically, Harman's single-factor test was conducted, and the results showed that eight eigenvalues were greater than 1, with the first factor accounting for 37.39% of the variance, falling below the critical threshold of 40%. Additionally, a single-factor confirmatory factor analysis was performed to test for common method bias across all self-reported items. The results indicated poor model fit, with the following fit indices: $\chi^2/df = 54.20$, CFI = 0.623, GFI = 0.729, AGFI = 0.574, NFI = 0.616, RMSEA = 0.236.

Table 1 Descriptive statistics and partial correlation analysis between variables ($N=465$)

Variables	M	SD	1	2	3	4
1.Self efficacy	29.35	6.38	1			
2.Meaning in life	54.83	9.92	0.47***	1		
3.Self esteem	29.87	4.11	0.44***	0.46***	1	
4.Professional identity	49.60	6.95	0.31***	0.62***	0.48***	1

Note: *** $P < 0.001$

**Fig. 1** Chain Mediation Path Model of Meaning in Life and Self-Esteem in the Relationship Between Self-Efficacy and Professional Identity

Therefore, the study did not exhibit serious common method bias.

Correlation analysis

After controlling for gender, age, and academic year, the correlation analysis results among the variables are presented in Table 1. Professional identity was showed significant positive correlations with meaning in life, self-esteem, and self-efficacy, with correlation coefficients of 0.624, 0.479, and 0.310, respectively (all p -values below 0.001). Similarly, meaning in life was significantly positively correlated with self-esteem and self-efficacy, with correlation coefficients of 0.456 and 0.464, respectively (all p -values below 0.001). Additionally, the correlation coefficient between self-esteem and self-efficacy was 0.438 ($p < 0.001$). These results suggest significant associations between professional identity, meaning in life, self-esteem, and self-efficacy, providing an important basis for subsequent hypothesis testing.

Mediation effect test

The mediation effect was tested using Wen and Ye's [67] recommended process. This approach combines the advantages of both sequential testing and the Bootstrap method, enhancing both the control of Type I error rates and the interpretability of the results. Specifically, the

analysis was conducted using Mplus software, which provides a complete set of results, including sequential testing and Bootstrap confidence intervals. After controlling for gender, age, and academic year, a Bootstrap method with 5000 resamples was applied to calculate the 95% confidence intervals of the mediation effects, ensuring the reliability and precision of the results.

Following the multiple mediation test procedure, the direct effects model was tested first, and the results showed that the direct effect path coefficient was significant ($\gamma = 0.187$, $p < 0.001$). Next, the mediation variables—meaning in life and self-esteem—were added to the model, and the results (see Fig. 1) indicated that all paths were significant except for the direct effect path ($\gamma = -0.151$, $p > 0.05$). The model fit indices were satisfactory, with the following values: $\chi^2/df = 4.35$, GFI = 0.95, NFI = 0.95, RFI = 0.92, IFI = 0.96, TLI = 0.94, CFI = 0.96, RMSEA = 0.08. These results suggest that the proposed model fits well and explains the data effectively.

The bias-corrected non-parametric percentile Bootstrap method was employed to randomly draw 5,000 samples from the original dataset to test the significance of the mediation effects. The Bootstrap analysis results (see Table 2) revealed that the mediation effect consisted of three indirect effect paths:

Table 2 Direct, indirect, and total effects in the multiple mediator model

Path	Estimated effect	Boot LLCI	Boot ULCI	Ratio
Direct effect				
SEF→PI	-0.15	-0.33	0.02	34%
All indirect effects	0.52	0.23	0.91	66%
SEF→MIL→PI	0.42	0.22	0.65	53.06%
SEF→SES→PI	0.04	0.01	0.11	5.2%
SEF→MIL→SES→PI	0.06	0.01	0.15	7.74%

Note: SEF, Self-efficacy. PI, Professional identity. MIL, Meaning in life. SES, Self-esteem. Boot LLCI, the lower bound of the 95% confidence interval. Boot ULCI, the upper limit of the 95% confidence interval (Percentile Bootstrap Method with Bias Correction). The Bootstrap sample size is set at 5000

Self-efficacy → meaning in life → professional identity The standardized path coefficient for this indirect effect was 0.418, with a confidence interval excluding 0 ($p < 0.001$). This result indicates that meaning in life significantly mediates the relationship between self-efficacy and professional identity, contributing to 53.06% of the total effect.

Self-efficacy → Self-esteem → professional identity The standardized path coefficient for this indirect effect was 0.041, with a confidence interval excluding 0 ($p < 0.001$). This suggests that self-esteem significantly mediates the relationship between self-efficacy and professional identity, although its contribution to the total effect was relatively smaller (5.20%).

Self-efficacy → meaning in life → Self-esteem → professional identity (chain mediation effect) The standardized path coefficient for this indirect effect was 0.061, with a confidence interval excluding 0 ($p < 0.001$). This finding highlights that the chain mediation effect via meaning in life and self-esteem significantly impacts professional identity, accounting for 7.74% of the total effect. These results indicate that self-efficacy positively influences professional identity through the mediating effects of meaning in life, self-esteem, and their chain mediation. These findings further confirm the robustness of the mediation effect and the theoretical model's validity.

Discussion

This study examined the relationship between self-efficacy and professional identity among pre-service PE teachers. The findings indicate a significant positive association between self-efficacy and professional identity, supporting Hypothesis H1. This result aligns with previous research [39, 40, 68], suggesting that that pre-service PE teachers with higher self-efficacy tend to demonstrate greater confidence in their teaching practice, respond more actively to teaching challenges, and exhibit a higher level of professional identity. In contrast, those with lower self-efficacy may lack confidence and effective coping strategies when facing teaching challenges, which could result in lower levels of professional identity

and potentially impact their career aspirations. While this study supports the association between self-efficacy and professional identity, further research employing longitudinal designs or experimental methods is needed to establish a clearer understanding of their causal relationship.

This study validated Hypothesis H2, revealing that meaning in life mediates the relationship between self-efficacy and professional identity. This finding is consistent with prior research and expands the understanding of how self-efficacy contributes to professional identity development [69]. Previous studies have suggested that individuals with higher self-efficacy tend to exhibit greater goal orientation and motivation. As an individual's perception of life goals and values, meaning in life plays a crucial role in shaping professional identity. By integrating these three variables, this study further clarifies how self-efficacy indirectly influences professional identity through the reinforcement of meaning in life. According to self-efficacy theory [30], individuals' confidence in their abilities affects their initiative and persistence, enabling them to face challenges with greater resilience and reinforcing their identification with their professional role. For pre-service PE teachers, higher self-efficacy may help them remain committed to their goals, perceive their efforts as meaningful, and strengthen their professional identity. Furthermore, meaning in life not only helps individuals recognize the intrinsic value of their profession but also enhances a sense of accomplishment and belonging [70], further motivating them to invest in their professional development. When pre-service PE teachers perceive their work as meaningful, they are more likely to develop a stronger professional identity and may also be more inclined to pursue a long-term teaching career. Future research could further investigate the long-term role of meaning in life in shaping professional identity and examine whether its effects vary across different stages of career development.

This study further validated Hypothesis H3, demonstrating that self-esteem mediates the relationship between self-efficacy and professional identity. This finding is consistent with previous studies, which indicate a positive association between self-efficacy and

self-esteem [46, 51, 53], as well as evidence suggesting that higher self-esteem contributes to professional identity development [53, 54]. This study further elucidates the underlying pattern of this relationship, indicating that self-efficacy is closely associated with self-esteem, which serves as a mediator between self-efficacy and professional identity. In other words, individuals with higher levels of self-efficacy tend to exhibit greater self-esteem, and those with higher self-esteem are generally more likely to develop a stronger sense of professional identity. Specifically, individuals with higher self-efficacy tend to exhibit greater confidence and a more positive attitude when facing professional challenges. They are more resilient in coping with stress and difficulties, which in turn strengthens their self-esteem. As self-esteem increases, individuals' recognition of their own competence and self-worth is further reinforced, contributing to a stronger sense of professional identity [26]. This mechanism aligns with the findings of Huang et al. [71], which suggest that self-efficacy and self-esteem are closely linked, and individuals with higher self-esteem typically exhibit greater professional identity and more proactive professional behaviors. From the perspective of social identity theory, professional identity can be seen as an extension of social identity, where an individual's sense of belonging to a specific professional group influences their professional identity [72]. For pre-service PE teachers, higher self-efficacy and self-esteem may not only lead to greater engagement in teaching practice but also foster a stronger sense of belonging and identification within the teaching community, further consolidating their professional identity [46]. This is particularly crucial given the marginalized status of physical education in many educational systems, where pre-service PE teachers often require additional psychological support to counteract societal undervaluation of their profession. Therefore, efforts to enhance the professional identity of pre-service PE teachers should not be limited to improving teaching skills and subject knowledge but should also focus on strengthening their self-efficacy and self-esteem to foster greater professional resilience.

This study further explored the chain mediating role of meaning in life and self-esteem in the relationship between self-efficacy and professional identity, supporting Hypothesis H4. This finding aligns with previous research, which has established a significant positive association between meaning in life and self-esteem [56, 73], both of which play crucial roles in the development of professional identity. Individuals with a stronger sense of meaning in life tend to exhibit higher self-esteem, and those with higher self-esteem are generally more likely to develop a stronger sense of professional identity [70]. The findings of this study further suggest that self-efficacy is closely associated with meaning in life and self-esteem,

which may contribute to greater confidence in the face of professional challenges and the development of a more stable self-concept, thereby being linked to the enhancement of professional identity. One key mechanism through which self-efficacy may influence professional identity is by enhancing meaning in life, helping individuals maintain confidence and recognize the value of their efforts in the face of occupational pressures and challenges. This strengthened sense of meaning, in turn, facilitates higher self-esteem, leading individuals to affirm their abilities and professional roles, which ultimately promotes professional identity development. Prior research has highlighted meaning in life as a form of psychological capital, suggesting that it helps individuals sustain motivation in their careers, enhance self-esteem, and strengthen professional identity [74]. Furthermore, the findings indicate that meaning in life and self-esteem are interrelated and may jointly contribute to professional development. A higher sense of meaning in life is not only associated with greater self-esteem but may also facilitate a more positive self-concept, which is further linked to the enhancement of professional identity. However, this mechanism is likely influenced by various contextual factors, including individual environments, social support, and career development stages [75, 76]. Future research could explore how these variables shape the applicability of this model across different cultural and social contexts, particularly in supporting pre-service PE teachers' professional identity development. Such investigations could provide educators with a more comprehensive theoretical foundation for designing effective interventions.

Theoretical implications

This study expands the theoretical framework of teacher professional identity and deepens the understanding of its development among pre-service PE teachers. Grounded in SDT, it explores the critical roles of self-efficacy, meaning in life, and self-esteem in the formation of professional identity, addressing gaps in existing research regarding the underlying psychological mechanisms of professional identity development. The findings suggest that self-efficacy is not only directly associated with professional identity but also indirectly related to it through meaning in life and self-esteem, offering a more nuanced perspective on the mechanisms underlying professional identity formation. Additionally, this study identifies the chain mediation effect of meaning in life and self-esteem in professional identity development, providing a new perspective on how individuals construct their professional identity throughout their career trajectories. These insights contribute to a more comprehensive understanding of teacher professional identity and serve

as a theoretical reference for future research exploring its development across different educational contexts.

Practical implications

The findings of this study have significant implications for pre-service PE teacher training and teacher education practices. First, the results highlight that enhancing self-efficacy is crucial for strengthening professional identity among pre-service PE teachers. Thus, teacher education programs should prioritize the development of teaching skills, classroom management strategies, and professional confidence, as these factors contribute to higher self-efficacy. Second, the study identifies meaning in life and self-esteem as key mediators in the formation of professional identity. This underscores the importance of helping pre-service PE teachers develop a positive professional value system, enhance their perception of meaning in their careers, and foster higher self-esteem. Educators can achieve this through reflective teaching practices, experiential learning opportunities, and constructive feedback [4], which can strengthen their sense of professional belonging and purpose. Furthermore, given the marginalized status of PE within the education system, the findings provide insights for policymakers and education administrators. Effective measures should be implemented to enhance the societal recognition of PE education and improve the professional development environment for pre-service PE teachers. By increasing institutional support and promoting the value of PE teaching, these strategies can foster greater professional identity and career stability among future PE teachers.

Limitations and future research directions

This study has several limitations. First, the cross-sectional design prevents the establishment of causal relationships among self-efficacy, meaning in life, self-esteem, and professional identity. Future research should adopt a longitudinal approach to track the development trajectory of professional identity among pre-service PE teachers and examine how these variables function at different career stages. Additionally, experimental studies could be conducted to assess the causal effects of psychological interventions on these variables. Second, the study sample was drawn from a single sports university in China, which limits the generalizability of the findings. Differences in cultural contexts and educational systems may shape the development of professional identity. Therefore, future research should incorporate cross-cultural comparisons to better understand how professional identity evolves in diverse settings. Third, the sample had a gender imbalance, with a higher proportion of male participants. While this reflects the general demographic trend in pre-service PE teacher programs, future research should include a more balanced gender representation

to examine the moderating role of gender in professional identity development. Finally, this study relied on self-reported data, which may be subject to social desirability bias. Future research should incorporate multiple data sources, such as peer evaluations and supervisor feedback, to enhance the reliability and validity of the findings.

Conclusion

This study examined the mechanisms linking self-efficacy, meaning in life, and self-esteem to the professional identity of pre-service PE teachers. The results indicated that self-efficacy is positively associated with professional identity, with meaning in life and self-esteem serving as mediators. Furthermore, the findings revealed a chain mediation effect, where self-efficacy influences professional identity through meaning in life and subsequently through self-esteem. Given the marginalized status of PE as a discipline, enhancing self-efficacy is particularly relevant for strengthening professional identity. This study suggests that teacher education programs should foster reflective practice, constructive feedback, and clear role expectations to support the development of self-efficacy, meaning in life, and self-esteem among pre-service PE teachers, ultimately promoting their professional identity.

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Author contributions

SP and YL were involved in the design of this study from its inception. MK and XXH participated in the entire process of distributing and collecting the questionnaires, providing essential support during the discussion of the results. SP was responsible for drafting the initial manuscript, while YL conducted detailed revisions and collaborated with the other authors to finalize the manuscript. All authors agreed to be accountable for all aspects of the manuscript, ensuring that any questions related to the accuracy or integrity of its content are appropriately investigated and resolved. Each author has read and approved the final version of the manuscript.

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Data availability

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Declarations

Ethics approval and consent to participate

The study was conducted in strict accordance with the principles of the Helsinki Declaration and was approved by the Ethics Committee of Capital University of Physical Education and Sports. Prior to participation in the survey, all participants provided informed consent by carefully reading and signing the consent form.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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