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Research paper

The impact of teacher deep collaboration on job satisfaction: Evidence from Chinese lower secondary teachers

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ABSTRACT

Grounded in social cognitive theory, this study investigates the relationship between teacher deep collaboration and job satisfaction, while examining the mediating roles of team innovation and teacher self-efficacy. Based on the data of 3,976 teachers across 198 schools in Shanghai, the study employed a MSEM approach. Results show that deep collaboration significantly enhances job satisfaction, with both partial and chain mediation effects of team innovation and self-efficacy being statistically significant. The findings underscore that teachers should shift from individualism to a more proactive, team-oriented mode of deep collaboration, which can effectively enhance their job satisfaction.

1. Introduction

Teacher job satisfaction plays a crucial role in promoting educational development, advancing reform, building a high-quality teaching workforce, and improving educational quality (Rechsteiner, 2022). Among the many factors influencing teaching effectiveness, job satisfaction is considered one of the core determinants (Alderman, 2013). Empirical evidence from both Eastern and Western contexts has consistently shown a positive relationship between teacher job satisfaction and teaching quality (Harrison et al., 2023). Satisfied teachers are more likely to invest their energy into supporting student success—not only delivering content, but also attending to students' individual needs to ensure academic achievement (Hoque et al., 2023). Higher job satisfaction is associated with greater enthusiasm and professional commitment in teaching, which in turn leads to improved instructional quality (Klusmann et al., 2008; Kunter et al., 2013). A sense of fulfillment also enhances teachers' emotional well-being and overall sense of happiness, making them more likely to establish supportive learning environments and use effective instructional strategies, which contributes to better student outcomes (Kyriacou & Sutcliffe, 1977). When teachers feel their work is meaningful, appreciated, and supported, they are more likely to remain committed to the profession and less prone to emotional exhaustion (Collie et al., 2012; Spilt et al., 2011). Conversely, low job satisfaction is often linked to higher attrition rates (Amitai & Van Houtte, 2022; Blömeke et al., 2017). Teachers who remain dissatisfied over time may choose to leave the profession or seek positions in other institutions. As such, improving teacher job satisfaction has become a global concern in the field of education.

Deep collaboration among teachers has been shown to enhance job satisfaction. By fostering a supportive team environment (Kyriacou & Sutcliffe, 1977; Vangrieken et al., 2015), promoting active engagement and close relationships (Goddard et al., 2010; Little, 1990), and providing professional feedback (Horn & Little, 2010; Supovitz, 2002), deep collaboration not only improves teachers' working conditions but also strengthens their self-efficacy, sense of belonging, and professional identity (Bandura, 1997; Jurkowski et al., 2023; Paju et al., 2022), thereby substantially contributing to job satisfaction (Toropova et al., 2021; Xia et al., 2023). However, although the positive impact of teacher collaboration has been widely acknowledged, existing research tends to overlook the distinction between superficial and deep forms of collaboration, often using the umbrella term "teacher collaboration." This may result in an underestimation or misinterpretation of the actual significance of deep collaboration in teaching practice (García-Martínez et al., 2021; James et al., 2007; Kolleck, 2019; Lin, 2022; Lopes & Oliveira, 2020; Reeves et al., 2017; Ronfeldt et al., 2015; Sims, 2017; Sun & Xia, 2018; Vangrieken et al., 2015; Williams, 2010). For example, teacher collaboration often focuses on routine instructional tasks, while deeper practices such as peer observation and feedback on teaching practices are less commonly involved (Horn & Little, 2010; Metropolitan Life Insurance Company, 2010; Nordgren et al., 2021). According to OECD

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reports, even in countries like China, the U.S., and Germany, where teacher collaboration is relatively frequent, the content and depth of collaboration are limited, lacking substantial professional engagement (OECD, 2019). Therefore, it is necessary to further conceptualize teacher deep collaboration to avoid confusion and provide more precise conclusions regarding its relationship with job satisfaction. At the same time, based on a review of research on teacher job satisfaction, we found that its measurement framework also has room for further refinement. Based on this, the first goal of this study is to clearly define the concept and dimensions of teacher deep collaboration, refine the assessment framework of job satisfaction, and further examine the relationship between teacher deep collaboration and job satisfaction.

Team innovation and teacher self-efficacy may serve as key mediating mechanisms in this relationship. Drawing on social cognitive theory, deep collaboration allows teachers to gain valuable experiences and feedback from colleagues, fostering professional growth and enhancing instructional innovation (Hsieh et al., 2024; Lin, 2022; Liu et al., 2022). Through identification with collective goals and shared success, collaboration also strengthens teachers' belief in their capacity to achieve instructional objectives (Bandura, 1997; Cai & Tang, 2021; Khan & Gupta, 2024; Çoban et al., 2023). These psychological and professional benefits further contribute to improved job satisfaction (Caprara et al., 2006; Demircioglu, 2023; Toropova et al., 2021). Therefore, a second objective of this study is to examine the mediating roles of team innovation and self-efficacy. Another important issue lies in understanding the relationship between team innovation and teacher self-efficacy. When individual teachers take a leading role in instructional practice, self-efficacy typically precedes their innovative behaviors and intentions—teachers who feel confident are more likely to engage in innovation (Bandura, 1997). However, deep collaboration helps to create a supportive environment that continuously reinforces teachers' instructional engagement and innovative practices, which in turn positively influences their sense of teaching efficacy (Bandura, 1997; Jiang & Chen, 2018; Reeves et al., 2017). Thus, the third aim of this research is to examine the chain mediation effect of team innovation and teacher self-efficacy in the relationship between teacher deep collaboration and job satisfaction.

Employing multilevel structural equation modeling (MSEM), the study analyzes data from the Shanghai sample of the 2018 Teaching and Learning International Survey (TALIS). By constructing and validating this model, the study provides empirical evidence to support the development of deep professional collaboration among teachers, thereby promoting improvements in their job satisfaction.

2. Literature review

2.1. Teacher deep collaboration

2.1.1. The definition of teacher deep collaboration

Teacher deep collaboration refers to teachers' active engagement in collective professional practices and collaboration within teaching teams, with the primary aim of improving instruction and fostering professional development. This concept is proposed as a refinement of the increasingly ambiguous and overly broad term "teacher collaboration" (García-Martínez et al., 2021; Kolleck, 2019; Reeves et al., 2017; Ronfeldt et al., 2015; Vangrieken et al., 2015). To clarify the meaning of deep collaboration and distinguish it from general forms of collaboration, it is necessary to briefly review the evolution of the term.

In the early stages, one of the main reasons for promoting teacher collaboration was the long-standing isolation of teachers in their work, a condition that undermined their opportunities for professional development, well-being, career stability, and emotional health (Schleifer et al., 2017). As a result, a substantial body of research began to focus on how to strengthen interactions among teachers to address this issue (Bryk et al., 1999; García-Martínez et al., 2021; Kolleck, 2019; Reeves et al., 2017; Ronfeldt et al., 2015; Vangrieken et al., 2015). Because of its simplicity and intuitive appeal, "teacher collaboration" has been widely used to describe professional interactions among teachers (Kolleck, 2019). As research deepened, various related concepts emerged to expand the scope and focus of teacher collaboration—such as teacher teams (Pounder, 1999), professional communities (Coburn & Russell, 2008; Thornton, 2006), professional learning communities (Scribner et al., 2002; Vescio et al., 2008), and communities of practice (Goodnough et al., 2009). These terms filled important gaps in the early literature.

However, as studies began applying these concepts more directly to instructional and curriculum practice, problems related to the ambiguity and lack of operational clarity of "teacher collaboration" became more apparent (García-Martínez et al., 2021; Kolleck, 2019; Reeves et al., 2017; Ronfeldt et al., 2015; Vangrieken et al., 2015). Definitions were often too broad, with no consistent standards for collaborative forms or content. Some studies also lacked methodological rigor, leading to inconsistent or unpredictable results (Fulton & Britton, 2011; Kelchtermans, 2006; Lomos et al., 2011; Reeves et al., 2017). In some cases, teacher collaboration was found to be ineffective or even harmful (Forte & Flores, 2014; Reeves et al., 2017). Several comprehensive reviews have highlighted the conceptual and methodological challenges still facing the field (García-Martínez et al., 2021; Kolleck, 2019; Reeves et al., 2017; Ronfeldt et al., 2015; Vangrieken et al., 2015). Even large-scale empirical studies show wide variation in the quality of collaboration across schools (Ronfeldt et al., 2015). As Vangrieken et al. (2015) emphasized, the lack of clear terminology makes it difficult to accurately interpret and apply empirical findings.

Therefore, it is critical to develop a more precise and structured terminology for teacher collaboration, especially as digital teaching continues to reshape the forms of instructional practice (Zhou et al., 2025; Zhu et al., 2025). A clear definition of "teacher deep collaboration" can help overcome current issues of conceptual inflation and inconsistency, providing a stronger theoretical foundation for educational practice and policy.

2.1.2. The dimensions of teacher deep collaboration

Based on a review of existing literature, teacher deep collaboration can be characterized by three core features: teacher team, active and sustained engagement, and providing instructional feedback.

Teacher team requires teachers to genuinely participate in collective instructional practices to achieve high-quality collaboration (Reeves et al., 2017; Wullschleger et al., 2023). A large-scale study in the U.S. by Ronfeldt et al. (2015) found that team teaching significantly improves instructional quality and teacher development. Teacher teams are also better positioned to identify student needs and design targeted responses (Strahan, 2003), a finding supported by experimental research (Gallimore et al., 2009). However, the presence of a team structure alone is not enough. Studies have shown that mandatory collaboration can provoke resistance (Forte & Flores, 2014), while voluntary and genuinely engaged teachers tend to demonstrate higher teaching performance and better student outcomes (Supovitz, 2002). Moving from general to deep collaboration involves a process of mutual adjustment among teachers with differing beliefs, which may involve conflict (Ohlsson, 2013; Supovitz, 2002). Therefore, advancing deep collaboration also requires teachers to participate in professional training on collaborative skills to ensure that the function of teacher team as intended (Somech, 2008).

Active and sustained engagement are essential for deep collaboration, as they enable teachers to access more meaningful learning opportunities and attain higher-quality professional development (Little, 2003). As early as the 1990s, Little (1990) proposed four levels of collaboration, suggesting that greater interdependence and closeness among teachers lead to deeper collaboration. This view has been confirmed by subsequent empirical studies (Goddard et al., 2007, 2010). Teachers' active participation and sustained connectedness are also reflected in the frequency of collaboration (Reeves et al., 2017). A national

survey of K–12 teachers found significant variation in both frequency and duration of collaboration (Metropolitan Life Insurance Company, 2010). Goddard et al. (2010) further emphasized that the frequency of instructional collaboration, the depth of engagement with instructional policies, and the degree of formal participation are key factors shaping collaboration quality. These findings suggest that internal motivation, rather than surface-level participation, is crucial. Therefore, the shift from individualism to collective responsibility marks a key dimension of deep collaboration (Avalos, 2011; Brouwer et al., 2012; Hargreaves & O'Connor, 2018; Little, 1990; Ohlsson, 2013; Stoll et al., 2006; Vangrieken et al., 2015).

Providing instructional feedback is another defining feature of deep collaboration. Although many teachers report collaborative involvement, such collaboration often centers on grading and test preparation rather than peer observation and feedback (Metropolitan Life Insurance Company, 2010). Yet, feedback is likely a critical component in improving collaboration quality. Horn and Little (2010) noted that while teacher teams can offer valuable learning opportunities, the outcomes depend heavily on the norms and structures of interaction. Even in tightly knit teams, effective strategies are still necessary (Ronfeldt et al., 2015). Supovitz (2002) found that teams engaging in co-teaching, peer observation, and feedback yielded better instructional outcomes. In Germany and Finland, resource sharing, structured feedback, and reflective teaching strategies among teachers have shown positive effects (Jurkowski et al., 2023; Paju et al., 2022; Richter et al., 2022). This observation further suggests that the cognitive investment and professional judgment required for providing instructional feedback may constitute one of the core mechanisms that distinguish deep collaboration from surface-level cooperation.

2.2. Teacher job satisfaction

In recent years, teacher job satisfaction has received increasing scholarly attention. It is commonly defined as teachers' subjective perceptions of their professional experiences (Evans, 1997; Spector, 2022; Weiss, 2002). Studies have shown that teacher job satisfaction encompasses multiple facets of the occupational environment, including both positive and negative psychological states experienced in the course of daily work (Agyapong et al., 2022; Cardoso & Costa, 2016; Locke, 1969; Skaalvik & Skaalvik, 2011a; Xiang et al., 2024). Teacher job satisfaction is primarily influenced by teacher-related, school-related, and society-related factors, which collectively shape teachers' work experiences and satisfaction levels (see Appendix I for a detailed review).

Given the diverse and complex nature of teachers' subjective experiences, researchers have approached the construct from multiple dimensions, thereby facilitating a more comprehensive assessment of teacher job satisfaction levels. For example, the TALIS 2018 survey operationalized teacher job satisfaction as a multidimensional construct, examining teachers' satisfaction with their work environment and their profession (Liu et al., 2023; OECD, 2019). Building on this conceptual foundation, and drawing from a systematic review of the relevant literature (Evans, 1997; Hakanen et al., 2006; Lopes & Oliveira, 2020; Meredith et al., 2023; Pepe et al., 2017; Simbula et al., 2011; Struyven & Vanthournout, 2014; Toropova et al., 2021), this study proposes a more refined framework for evaluating teacher job satisfaction. Specifically, four core dimensions are identified: material satisfaction, self-worth satisfaction, cultural satisfaction, and developmental satisfaction. This classification aims to more precisely capture teachers' workplace experiences and offers a solid theoretical basis for comprehensive evaluation.

- **Material Satisfaction:** Refers to teachers' subjective appraisal of their working conditions, material rewards, and access to institutional resources. This includes evaluations of salary, school infrastructure, and teaching materials (Arokiasamy et al., 2013; Chapman & Lowther, 1982; Hoque et al., 2023; Kwantes, 2010; Liang, 2020; Liu et al., 2021; Nyamubi, 2017). Favorable material conditions not only contribute to overall well-being (Kwantes, 2010; Lopes & Oliveira, 2020), but also significantly influence teachers' satisfaction with their working environment (Brezicha et al., 2020; Evans, 1997; Park et al., 2023; Toropova et al., 2021; Worrell et al., 2006; Xiu et al., 2022).
- **Self-Value Satisfaction:** Reflects the sense of personal fulfillment and psychological gratification that teachers gain from their professional roles. This dimension includes perceived goal attainment, recognition of personal value (Meredith et al., 2023), teaching efficacy (Barni et al., 2019; Caprara et al., 2006; Chamani et al., 2023; Ortan et al., 2021), and evaluations received from others (Bjorklund Jr et al., 2021; Lavy & Bocker, 2018). Some scholars argue that self-perception, emotional experience, and teaching behavior jointly form the foundation of teacher job satisfaction (Judge & Kammeyer-Mueller, 2012). When teachers are able to realize personal goals and receive affirmative feedback, their satisfaction with their work tends to increase significantly (Coomber & Barriball, 2007; Evans, 1997; Fütterer et al., 2023; Harrison et al., 2023; Ortan et al., 2021).
- **Cultural Satisfaction:** Involves teachers' perceived alignment with the broader cultural environment of the school. It includes a sense of belonging (Skaalvik & Skaalvik, 2011b), perceptions of school management and organizational culture (Karousiou et al., 2019; Zang et al., 2022), communication patterns and leadership style (Honingh & Hooge, 2014), instructional autonomy, and opportunities for participatory decision-making (Brezicha et al., 2020; Grissom et al., 2014; Ortan et al., 2021; Park et al., 2023). Research shows that when teachers perceive the school culture as supportive and inclusive, their sense of professional identity and job satisfaction are significantly enhanced (Admiraal et al., 2016; Evans, 1997; Skaalvik & Skaalvik, 2018).
- **Developmental Satisfaction:** Pertains to teachers' perceptions of professional growth opportunities, career advancement, and promotion pathways (Nyamubi, 2017; Sahito & Vaisanen, 2020). This dimension reflects whether long-term career expectations are being met, thereby influencing professional commitment and work engagement. Access to professional development, a transparent career path, and fair promotion mechanisms all contribute to greater satisfaction (Hakanen et al., 2006; Simbula et al., 2011; Struyven & Vanthournout, 2014).

It is important to recognize that different teaching contexts may give rise to variations in satisfaction structures. Many studies target specific teacher populations, and these context-specific characteristics often influence which satisfaction dimensions are most salient (Toropova et al., 2021). For instance, in economically advantaged regions, teachers may prioritize self-fulfillment and career advancement, whereas in resource-constrained environments, material conditions may play a more critical role in shaping satisfaction (Chapman & Lowther, 1982; Nyamubi, 2017; Saiti & Papadopoulos, 2015; Toropova et al., 2021). Overall, the core dimensions of teacher job satisfaction align with these four aspects. This classification provides a structured analytical lens for future research and practical guidance for education administrators seeking to improve teachers' workplace conditions.

3. Theoretical framework and hypotheses development

3.1. Social cognitive theory

This study aims to examine the impact of teacher deep collaboration on job satisfaction, while also investigating the mediation effects of team innovation and teacher self-efficacy. The underlying mechanism involves the interplay of individual behavior, organizational environment, and cognitive processes. Therefore, it is essential to adopt a robust theoretical framework to integrate these elements.

Although several existing theories address teacher collaboration—for example, social capital theory (SCT) emphasizes trust and resource sharing among teachers to foster stronger collaboration (Moolenaar et al., 2012), organizational learning theory (OLT) focuses on knowledge transfer and adaptive processes within collaborative settings (Thoonen et al., 2011), and self-determination theory (SDT) explores the role of motivation, autonomy, and satisfaction—these frameworks fall short in adequately explaining the mechanisms underlying the influence among deep collaboration, innovation, self-efficacy, and job satisfaction.

In contrast, social cognitive theory (SCT), through its triadic reciprocal determinism, posits that individual behavior, environmental factors, and cognitive beliefs operate as a mutually influential system (Bandura, 1986). This theoretical model aligns well with the core constructs of the present study: within a context of deep collaboration, teachers' innovative intentions and behaviors are fostered, reinforcing their self-efficacy beliefs and ultimately enhancing job satisfaction. Social cognitive theory not only explains how teacher behaviors influence innovation but also highlights how professional identity and competence beliefs are actively constructed through collective practice and feedback, thereby influencing job satisfaction. Therefore, this study adopts SCT as the unified theoretical framework.

3.2. Teacher deep collaboration and job satisfaction

Teacher deep collaboration emphasizes three key features: teacher team, active and sustained engagement, and instructional feedback. According to Social Cognitive Theory (SCT), such socially embedded behaviors not only improve teachers' working conditions but also enhance job satisfaction through mechanisms such as observational learning, efficacy building, and identity reinforcement (Bandura, 1997).

Engaging in team-based teaching practices creates a supportive and interactive work environment. Teachers who actively participate in collaborative teams both give and receive support, which helps reduce stress and burnout (Kyriacou & Sutcliffe, 1977; Vangrieken et al., 2015), thereby enhancing their job satisfaction (Toropova et al., 2021; Xia et al., 2023). Participation in collective decision-making also increases teachers' sense of autonomy and commitment, fostering a sense of ownership and contributing to greater satisfaction (Somech, 2010). Deep collaboration also helps dismantle professional isolation, promotes strong interpersonal relationships and positive team climate, and strengthens teachers' emotional engagement and sense of belonging (Schleifer et al., 2017).

Teachers' active engagement and close relationships enhance the continuity, frequency, and emotional quality of collaboration (Goddard et al., 2010; Little, 1990; Metropolitan Life Insurance Company, 2010). SCT suggests that such close interactions provide teachers with more opportunities for observational learning and verbal persuasion, which improve the efficiency, frequency, and quality of knowledge transfer, while also fostering interpersonal trust (Goddard et al., 2004, 2007).

Deep collaboration also provides teachers with meaningful professional feedback, allowing them to invest cognitive resources to build greater professional competence (Horn & Little, 2010; Richter et al., 2022; Supovitz, 2002). According to SCT, providing feedback contributes to teachers' professional growth by offering enactive mastery experiences, allowing teachers to perceive ongoing improvements in their competence, which in turn contributes to a more fulfilling work experience. such engagement is a form of enactive mastery experience, through which teachers perceive their competence and value by observing their impact on others.

The act of giving feedback not only strengthens teachers' professional influence but also reinforces their sense of identity and meaning as educators, ultimately increasing job satisfaction (Jurkowski et al., 2023; Paju et al., 2022). Therefore, we assume:

H1. Teacher deep collaboration has a significant positive effect on teacher job satisfaction.

3.3. The mediation effect of team innovation and teacher self-efficacy

3.3.1. The mediation effect of team innovation

Teacher team innovation refers to teachers' attitudes toward innovation and their proactive engagement in innovative practices (Wu, 2021). According to SCT, team innovation mediates the relationship between deep collaboration and job satisfaction (Bandura, 1986). Deep collaboration establishes a socially embedded psychological network: teachers gain confidence through collaboration, acquire models through observation, reconstruct understanding through feedback, and align goals with motivation. This mechanism transforms deep collaboration from a static structure into a social-cognitive engine that drives sustained instructional innovation. It helps teachers develop positive outcome expectations, thereby enhancing their willingness and behavior to innovate (Bandura, 1997; Yuan & Woodman, 2010). This process also meets teachers' psychological needs in their profession, strengthening their positive work cognition and increasing job satisfaction (Collie et al., 2012; Jiang & Chen, 2018).

This study argues that teacher deep collaboration promotes team innovation. Such collaboration requires active participation and engagement from individual teachers, representing a collaborative model that surpasses hierarchical or competitive approaches (Roberts, 2000). Research indicates that in high-level collaborative environments, close professional interactions, shared learning, and feedback among teachers foster a highly supportive team climate. This allows teachers to focus more on instructional practices and the development of new pedagogical ideas, increasing both their intention and behavior to innovate (Darling-Hammond, 2017; Nielsen et al., 2008; Çoban & Atasoy, 2020). Deep collaboration encourages deeper dialogue and feedback, which helps teachers gain new perspectives and revisit old problems, triggering innovative thinking and practices (McCharen et al., 2011; Roberts, 2000; Rubenstein et al., 2018). Joint teaching supports the development of shared team missions, constructive management of differences, and collective problem-solving, further activating teacher participation and innovation potential (Liu et al., 2022; Lu & Campbell, 2021; Torfing, 2019). Other studies suggest that highly collaborative teacher teams can generate more innovative thinking and practices than individual teachers (Lin, 2022).

Team innovation enhances job satisfaction by fulfilling teachers' psychological needs (Deci et al., 2017). Studies show that teachers with more positive attitudes toward innovation display greater initiative and creativity, which increases their sense of control and autonomy in teaching (Lam et al., 2010). In collaborative contexts, teachers directly experience the outcomes and feedback of their innovations, which significantly boosts their sense of competence (Deci & Ryan, 2000). Both positive and negative feedback can help teachers refine and optimize instructional strategies, improving their work experience (Reeves et al., 2017). Fulfilling these psychological needs is a key determinant of teachers' intrinsic motivation, emotional state, and satisfaction (Deci & Ryan, 2000; Nie et al., 2015; Skaalvik & Skaalvik, 2014). Teacher deep collaboration provides an innovation-conducive supportive environment and helps satisfy basic psychological needs, thereby promoting job satisfaction (Collie et al., 2012; Jiang & Chen, 2018). Based on this, we hypothesize:

H2. Team innovation partially mediates the relationship between deep collaboration and teacher job satisfaction.

3.3.2. The mediation effect of teacher self-efficacy

Bandura's social cognitive theory emphasizes the dynamic interplay among individual behavior, environmental factors, and cognitive processes (Bandura, 1997). One of its core concepts, self-efficacy, refers to an individual's belief or confidence in their ability to successfully perform a specific task or behavior (Bandura, 1997). Within the context

of primary and secondary education, teacher self-efficacy is typically conceptualized as comprising three dimensions: efficacy in student engagement, instructional strategies, and classroom management (Liu et al., 2023; Tschannen-Moran & Hoy, 2001). Among these, efficacy in student engagement refers to teachers' confidence in their ability to motivate students to actively participate in class, reflecting their belief in enhancing students' interest, motivation, and participation (Ainley, 2018). In this study, student engagement efficacy is used as the primary indicator of teacher self-efficacy.

Teacher deep collaboration can promote teachers' self-efficacy. Deep collaboration among teachers fosters frequent and high-quality interactions, which provide opportunities for vicarious experience and verbal persuasion—two key sources of efficacy development (Bandura, 1997). For example, such collaboration not only enhances communication quality but also facilitates peer learning, experience sharing, and joint reflection. These collaborative experiences strengthen teachers' beliefs in their professional competence and improve their abilities to apply instructional theories, teaching strategies, and problem-solving skills (Darling-Hammond, 2017; Liu et al., 2021; Çoban et al., 2023). Moreover, constructive feedback and mutual support in collaborative settings provide a persuasive and emotionally supportive environment, reinforcing teachers' confidence in their ability to effectively engage students. In terms of the cooperative environment, encouraging and supporting teacher collaboration contributes to a more open and positive work environment, where teachers can readily observe successful peer practices. These vicarious experiences generate stronger efficacy expectations, reinforcing their belief that they too can effectively foster student motivation (Liu et al., 2023; Tschannen-Moran & Hoy, 2001). In this way, deep collaboration promotes collective teacher self-efficacy across the school. Notably, even in settings where deep collaboration is not fully realized, studies suggest that focused collaboration on instructional tasks can still positively influence teacher self-efficacy (James et al., 2007; Williams, 2010).

Teacher self-efficacy is also positively associated with job satisfaction (Bandura, 1997; Caprara et al., 2006; Toropova et al., 2021). As a positive psychological resource, self-efficacy enables teachers to make more favorable evaluations of their instructional competence and professional value (Bandura, 1997). High teacher self-efficacy can buffer the negative effects of a stressful work environment. Teachers with strong self-efficacy are more likely to perceive such challenges as manageable and are better equipped to respond constructively—ultimately contributing to higher job satisfaction (Skaalvik & Skaalvik, 2014; Toropova et al., 2021). Teachers with higher self-efficacy not only report greater job satisfaction but also show significantly lower levels of turnover intention (Klassen & Chiu, 2010; Skaalvik & Skaalvik, 2014). Numerous international studies have confirmed that teacher self-efficacy plays a significant mediating role in the relationship between collaborative practices and job satisfaction (Khan & Gupta, 2024; Liu et al., 2023; Lopes & Oliveira, 2020; Malinen & Savolainen, 2016). So, we can hypothesize:

H3. Teacher self-efficacy partially mediates the relationship between deep collaboration and teacher job satisfaction.

3.3.3. The chain mediation effect of team innovation and teacher self-efficacy

Team innovation and teacher self-efficacy jointly serve as a chain mediating mechanism through which teacher deep collaboration influences job satisfaction. While previous discussions have addressed how deep collaboration fosters team innovation, it is equally important to examine the impact of innovation on teacher self-efficacy. According to social cognitive theory, team innovation itself is an important source of self-efficacy for teachers (Bandura, 1997). At the school level, a high degree of team innovation reflects the collective engagement of teachers in actively exploring and implementing new pedagogical strategies and ideas. Such collaboration enables more effective mutual support, resource sharing, and joint problem-solving, thereby enhancing teachers' sense of instructional control and overall confidence (Chong & Kong, 2012; Goddard et al., 2015; Lee & Tsai, 2010; Vangrieken et al., 2017). At the individual level, through sustained cooperation and innovation with team members, teachers are able to accumulate valuable social resources, which in turn help to protect and reinforce key psychological resources such as self-efficacy. This process not only mitigates professional stress but also contributes to greater job satisfaction (Hobfoll, 1989).

However, when discussing the link between team innovation and teacher self-efficacy, it is essential to distinguish between different research contexts—specifically, between individual innovation and collaborative innovation. When research focuses on individual-level innovation, teacher self-efficacy is often seen as a key psychological driver. As Bandura (1997) suggests, teachers with high self-efficacy are more inclined to proactively adopt new teaching methods and technologies in response to instructional challenges or educational reforms. They believe in their ability to manage difficulties and persist in refining their teaching strategies, even when facing setbacks. This perspective has been widely supported by empirical research (Allinder, 1994; Buske, 2018; Cai & Tang, 2021; Hsieh et al., 2024; Liu et al., 2022). When the analytical focus shifts from individual teachers to collaborative team contexts, the mechanisms of influence differ. In the context of deep collaboration, teachers engage in innovation through collective learning, peer feedback, joint decision-making, and shared evaluation and refinement of instructional methods. Such team-based innovation significantly enhances the collective capacity for teaching improvement and can generate a broader "ripple effect," extending the impact of educational reform and innovation (Buske, 2018). At the same time, the positive effects of the teaching team will also act as an environmental factor, further strengthening the self-efficacy of individual teachers. Through active participation in team-based innovation, teachers develop a clearer sense of their own capabilities and the tangible outcomes of their efforts, thereby strengthening their intrinsic motivation and willingness to explore new ideas (Jiang & Chen, 2018; Reeves et al., 2017).

These findings collectively support the view that team innovation and teacher self-efficacy function together as a chain mediating pathway in the relationship between deep collaboration and teacher job satisfaction. That is, teacher deep collaboration not only directly enhances job satisfaction, but also indirectly strengthens it by fostering innovation and reinforcing self-efficacy. Therefore, it can be assumed that:

H4. Team innovation and teacher self-efficacy jointly form a chain mediating path in the relationship between deep collaboration and teacher job satisfaction.

4. Methods

4.1. Data source and procedure

The data used in this study were sourced from the Teaching and Learning International Survey (TALIS), conducted by the Organisation for Economic Co-operation and Development (OECD) in 2018. TALIS is an international survey that focuses on teachers' working conditions, school learning environments, teachers' professional development, and the effectiveness of educational policies. The survey employs a stratified two-stage probability sampling design to collect data from teachers and principals across various countries. In the first stage, schools are randomly selected, and in the second stage, approximately 20 teachers are randomly chosen from each selected school. This study uses sample data from Shanghai, China (CSH), covering 3976 junior high school teachers from 198 schools. Among these participants, 2941 (74 %) are female teachers, and 1035 (26 %) are male teachers. TALIS 2018 data and procedures are publicly accessible and designed to support international scholarly research. All participants took part voluntarily and

Table 1
Demographic information.

Variables		Count	Percentage
Gender	Female	2941	74.0 %
	Male	1035	26.0 %
Age	Under 25	119	3.0 %
	25–29	532	13.4 %
	30–39	1316	33.1 %
	40–49	1418	35.7 %
	50–59	564	14.2 %
	60 and above	24	0.6 %
	Missing	1	0.0 %
Educational Attainment	College	35	0.9 %
	Bachelor's	3413	86.1 %
	Master's	514	13.0 %
	Doctorate	1	0.0 %
	Missing	13	0.0 %
Career Stage	Early (≤8 years)	973	24.5 %
	Mid (9–23 years)	1909	48.2 %
	Late (≥24 years)	1071	27.2 %
	Missing	23	0.6 %

were informed of the intended use of the data for scientific research. For more detailed demographic information, please see Table 1.

4.2. Measures

All variables used in this study were derived from the 2018 TALIS teacher questionnaire (OECD, 2018). These variables were assessed using 4-point and 6-point Likert scales. The scales for each variable were created through confirmatory factor analysis (CFA) based on relevant items in the questionnaire.[2] School-level variables in this study were generated from teacher-level variables using multilevel latent covariate modeling (MLC). Fig. 1 shows the theoretical framework of this paper.

Teacher Deep Collaboration: In the TALIS 2018 survey, teacher deep collaboration (T3COLES) was assessed through four items: collaboration in teaching teams, providing feedback based on classroom practice to other teachers, joint participation in teaching-related activities, and collaborative professional learning. This construct was developed based on questionnaire item *TT3G33. Each item is measured using a six-point frequency scale, evaluating the frequency with which teachers engage in the respective collaborative practices, with higher scores indicating more frequent engagement. In the Shanghai sample, this scale demonstrated acceptable reliability with McDonald's ω = 0.712. For the complete scale information, please refer to Table 2.

Team Innovation: Derived from questionnaire item *TT3G32, team innovation (T3TEAM) was assessed using four items that capture the extent to which teachers engage in innovative teaching ideas, demonstrate proactive innovation behaviors, cultivate innovative thinking, and provide mutual support for implementing innovations. This scale was measured using a four-point agreement scale, where higher scores reflect greater levels of team innovation. In the Shanghai sample, this scale demonstrated excellent reliability with McDonald's ω = 0.953. Detailed information on the scale items can be found in Table 3.

Teacher Self-Efficacy: Teacher self-efficacy (T3SEENG) was measured using four items reflecting teachers' perceived ability to support students in believing in themselves, valuing learning, staying motivated, and thinking critically. The items were derived from the question *TT3G34. Responses were recorded on a 4-point agreement scale. The scale showed good reliability in the Shanghai sample with McDonald's ω = 0.882. See Table 4 for the full scale.

Teacher Job Satisfaction: This study assessed job satisfaction using the TALIS 2018 variable T3JOBSA, which includes two subscales: satisfaction with the work environment (T3JSENV) and satisfaction with the profession (T3JSPRO). These items align with the four-dimensional framework of job satisfaction proposed in this study (see Appendix II for more detailed classifications). The scale is based on eight items from the question *TT3G53. Responses were measured on a 4-point Likert agreement scale. In the Shanghai sample, the scale showed high reliability with Cronbach's α = 0.882. Please refer to Table 5 for the complete scale.

4.3. Data analysis

This study first conducted preliminary analyses of the main variables using descriptive statistics and correlation analysis in SPSS 29. Subsequently, a two-level Multilevel Structural Equation Modeling (MSEM) approach based on the Multilevel Latent Covariate (MLC) strategy was employed, with robust maximum likelihood estimation (MLR) performed in Mplus 8.3. The analysis focused on estimating both the direct and indirect effects at the teacher level. The adoption of MSEM was based on two main considerations:

(1). The nested structure of the data. Teachers are naturally nested within schools, introducing intra-group correlation that violates the independence assumption of residuals in OLS regression and increases the risk of Type I errors (Raudenbush & Bryk, 2002). MSEM accounts for measurement error and reduces estimation bias (Preacher, 2011).

(2). High flexibility and accuracy. the MLC strategy allows researchers to flexibly account for group-level effects depending on the intraclass correlation coefficient (ICC). This method decomposes observed variables into within-group and between-group components and separately estimates their variances at each level (Muthen & Asparouhov, 2011). When between-group variance is substantial (i.e., high ICC), group-level models can be specified. When the ICC is low, multilevel models remain capable of isolating between-group variance from the total variance, thereby preventing cross-level confounding and enhancing the accuracy of parameter estimates of teacher level model (Preacher et al., 2016).

5. Results

5.1. Descriptive statistics and correlations

Table 6 presents the descriptive statistics and correlation results for the main variables in this study. The results show that team innovation had the highest average score (M = 12.24, SD = 2.01), followed by teacher job satisfaction (M = 12.08, SD = 1.85) and teacher self-efficacy (M = 11.93, SD = 2.59), with teacher deep collaboration having the lowest average score (M = 9.12, SD = 1.95). The results of the data distribution test indicated that the skewness of all variables was less than |1| and the kurtosis was less than |2|, which falls well within the acceptable range for the MLR estimation method. Correlation analysis indicated significant positive correlations between teacher deep collaboration and team innovation, teacher self-efficacy, and teacher job satisfaction (rs > 0.25, p 0.05). These results provide preliminary insights into the relationships among the study variables, supporting the next step of constructing a multilevel structural equation model.

5.2. Establish the MLC-MSEM model

Teacher-level variables were incorporated into a two-level model, with variance decomposed at each level. The analysis primarily focused on estimating the direct and indirect effects at the individual (teacher) level. Measurement models were constructed based on Matrix 1 (see Fig. 2), within-group structural equation models based on Matrix 2 (see

[2] The sample from Shanghai, China, reported good CFA results. For specific confirmatory factor analysis parameters, please see the TALIS 2018 technical report: https://www.oecd.org/education/talis/TALIS_2018_Technical_Report.pdf.

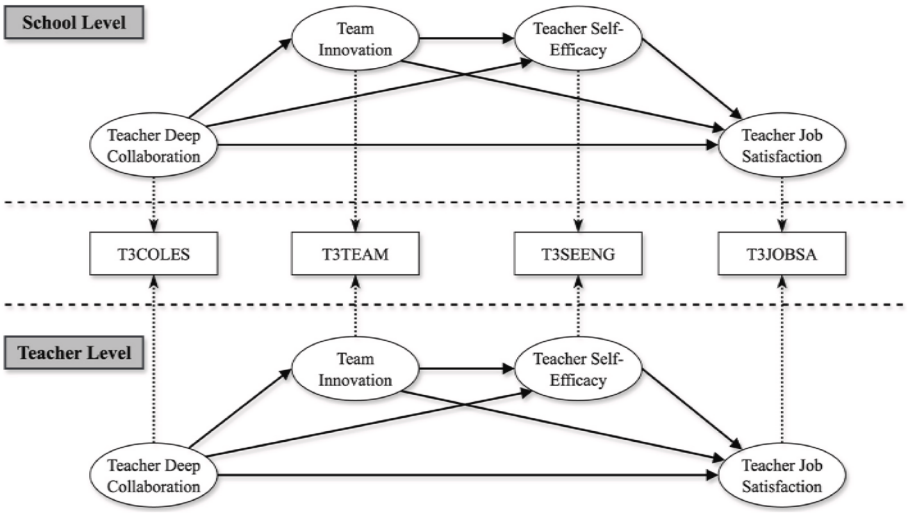

Fig. 1. Theoretical framework.

Table 2
Teacher deep collaboration scale.

Variable	TALIS Code	Items
Teacher Deep Collaboration	*TT3G33	(Question) On average, how often do you do the following in this school?
	TT3G33A	1. Teach jointly as a team in the same class.
	TT3G33B	2. Provide feedback to other teachers about their practice.
	TT3G33C	3. Engage in joint activities across different classes and age groups (e.g. projects).
	TT3G33H	4. Participate in collaborative professional learning.

Note: The response scale for the teacher deep collaboration scale was: 1 = Never, 2 = Once a year or less, 3 = 2–4 times a year, 4 = 5–10 times a year, 5 = 1–3 times a month, and 6 = Once a week or more.

Table 3
Team innovation scale.

Variable	TALIS Code	Items
Team Innovation	*TT3G32	(Question) Thinking about the teachers in this school, how strongly do you agree or disagree with the following statements?
	TT3G32A	1. Most teachers in this school strive to develop new ideas for teaching and learning.
	TT3G32B	2. Most teachers in this school are open to change.
	TT3G32C	3. Most teachers in this school search for new ways to solve problems.
	TT3G32D	4. Most teachers in this school provide practical support to each other for the application of new ideas.

Note: The response scale for the team innovation scale was: 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree.

Fig. 3), and between-group structural equation models based on Matrix 3 (see Fig. 4) (Preacher et al., 2016). In these matrices, *i* represents individual teachers and *j* represents schools. For instance, *COij* denotes the level of teacher deep collaboration for the ith teacher in the jth school, while other variables such as team innovation (TI), teacher self-efficacy (SE), and job satisfaction (JS) are similarly abbreviated.

The MSEM model demonstrated good fit, with the following fit indices: SRMRwithin = 0.002, SRMRbetween = 0.03, AIC = 66080.889, and BIC = 66225.496. These fit indices indicate that the model effectively explains the relationships between variables across different levels.

Table 4
Teacher self-efficacy scale.

Variable	TALIS Code	Items
Teacher Self-Efficacy	*TT3G34	(Question) In your teaching, to what extent can you do the following?
	TT2G34A	1. Get students to believe they can do well in school work.
	TT2G34B	2. Help students value learning.
	TT2G34E	3. Motivate students who show low interest in school work.
	TT2G34G	4. Help students think critically.

Note: The response scale for the teacher self-efficacy scale was: 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree.

Table 5
Teacher job satisfaction scale.

Variable	TALIS Code	Items
Teacher Job Satisfaction	*TT3G53	(Question) We would like to know how you generally feel about your job. How strongly do you agree or disagree with the following statements?
	TT3G53C*	1. I would like to change to another school if that were possible.
	TT3G53E	2. I enjoy working at this school.
	TT3G53G	3. I would recommend this school as a good place to work.
	TT3G53J	4. All in all, I am satisfied with my job.
	TT3G53A	5. The advantages of being a teacher clearly outweigh the disadvantages.
	TT3G53B	6. If I could decide again, I would still choose to work as a teacher.
	TT3G53D*	7. I regret that I decided to become a teacher.
	TT3G53F*	8. I wonder whether it would have been better to choose another profession.

Note: The response scale for the teacher job satisfaction scale was: 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree.

5.3. Multilevel structural equation model at the teacher level

Direct Effect Test. The results revealed that at the teacher level, the independent variable teacher deep collaboration had a significant direct

Table 6
Descriptive statistics and correlations.

Variables	Descriptive		Distribution		Correlations			
	M	SD	skewness	kurtosis	TDC	TI	TSE	TJS
TDC	9.12	1.95	0.33	0.19	–			
TI	12.24	2.01	0.59	1.56	0.29***	–		
TSE	11.93	2.59	0.31	0.53	0.27***	0.27***	–	
TJS	12.08	1.85	0.10	0.72	0.25***	0.36***	0.26***	–

Note: N = 3976; M = Mean, SD = Standard deviation; TDC = Teacher deep collaboration; TI = Team innovation; TSE = Teacher self-efficacy; TJS = Teacher job satisfaction; *p 0.05, **p 0.01, ***p 0.001, the same as below.

$$Y_{ij}=\Lambda\eta_{ij}=\begin{bmatrix} CO_{ij} \\ TI_{ij} \\ SE_{ij} \\ JS_{ij} \end{bmatrix}=\left[\begin{array}{cccc|cccc} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \end{array}\right]\left[\begin{array}{c} \eta_{COij} \\ \eta_{TIij} \\ \eta_{SEij} \\ \eta_{JSij} \\ \hdashline \eta_{COj} \\ \eta_{TIj} \\ \eta_{SEj} \\ \eta_{JSj} \end{array}\right]$$

Fig. 2. Measurement model.

effect on the dependent variable teacher job satisfaction (β = 0.087, p 0.001). Additionally, teacher deep collaboration significantly predicted the two mediators, team innovation (β = 0.214, p 0.001) and teacher self-efficacy (β = 0.196, p 0.001). Furthermore, both team innovation and teacher self-efficacy positively and significantly influenced job satisfaction (βs > 0.100, ps 0.001), and team innovation significantly predicted teacher self-efficacy (β = 0.199, p 0.001). These findings suggest that the more frequently teachers engage in deep collaboration, the higher their levels of team innovation, self-efficacy, and job satisfaction. Higher levels of team innovation or teacher self-efficacy are both significantly associated with increased job satisfaction. Moreover, improvements in team innovation directly enhance teachers' self-efficacy, thereby reinforcing their confidence in teaching. Hypothesis H1 is supported.

Partial Mediation Effect Test. The mediation analysis indicated that team innovation played a significant partial mediating role in the positive relationship between teacher deep collaboration and job satisfaction (β = 0.054, p 0.001). Teacher self-efficacy also served as a significant mediator in this relationship (β = 0.026, p 0.001). This suggests that teacher deep collaboration contributes to greater job satisfaction both directly and indirectly through the enhancement of team innovation and self-efficacy. In terms of proportion of indirect effects, the mediating effect of teacher self-efficacy was relatively small (MP_{TSE} = 14.3 % 20 %), indicating a limited role. In contrast, the mediating effect of team innovation was moderate (MP_{TI} = 29.2 % ∈ [20 %, 40 %]), suggesting a more prominent influence in this path. Therefore, at the teacher level, while the mediators contribute meaningfully, teacher deep collaboration remains the primary factor influencing job satisfaction. The results supported both H2 and H3.

Chain Mediation Effect Test. Further analysis revealed a significant sequential mediation effect of team innovation and teacher self-efficacy in the relationship between teacher deep collaboration and job

$$\eta_{ij}=\alpha_j+B_j\eta_{ij}+\zeta_{ij}=\begin{bmatrix} \eta_{COij} \\ \eta_{TIij} \\ \eta_{SEij} \\ \eta_{JSij} \\ \hdashline \eta_{COj} \\ \eta_{TIj} \\ \eta_{SEj} \\ \eta_{JSj} \end{bmatrix}=\begin{bmatrix} \alpha_{\eta COj} \\ \alpha_{\eta TIj} \\ \alpha_{\eta SEj} \\ \alpha_{\eta JSj} \end{bmatrix}+\begin{bmatrix} 0 & 0 & 0 & 0 \\ B_{TICOj} & 0 & 0 & 0 \\ B_{SECOj} & B_{SETIj} & 0 & 0 \\ B_{JSCOj} & B_{JSTIj} & B_{JSSEj} & 0 \end{bmatrix}\begin{bmatrix} \eta_{COij} \\ \eta_{TIij} \\ \eta_{SEij} \\ \eta_{JSij} \\ \hdashline \eta_{COj} \\ \eta_{TIj} \\ \eta_{SEj} \\ \eta_{JSj} \end{bmatrix}+\begin{bmatrix} \zeta_{COij} \\ \zeta_{TIij} \\ \zeta_{SEij} \\ \zeta_{JSij} \end{bmatrix}$$

Fig. 3. Teacher level (within group) structural equation.

$$\eta_j=\mu+\beta\eta_j+\zeta_j=\begin{bmatrix} \alpha_{\eta COj} \\ \alpha_{\eta TIj} \\ \alpha_{\eta SEj} \\ \alpha_{\eta JSj} \end{bmatrix}=\begin{bmatrix} \mu_{\alpha_{\eta COj}} \\ \mu_{\alpha_{\eta TIj}} \\ \mu_{\alpha_{\eta SEj}} \\ \mu_{\alpha_{\eta JSj}} \end{bmatrix}+\begin{bmatrix} 0 & 0 & 0 & 0 \\ \beta_{TICO} & 0 & 0 & 0 \\ \beta_{SECO} & \beta_{SETI} & 0 & 0 \\ \beta_{JSCO} & \beta_{JSTI} & \beta_{JSSE} & 0 \end{bmatrix}\begin{bmatrix} \alpha_{\eta COj} \\ \alpha_{\eta TIj} \\ \alpha_{\eta SEj} \\ \alpha_{\eta JSj} \end{bmatrix}+\begin{bmatrix} \zeta_{\alpha\eta COj} \\ \zeta_{\alpha\eta TIj} \\ \zeta_{\alpha\eta SEj} \\ \zeta_{\alpha\eta JSj} \end{bmatrix}$$

Fig. 4. School level (between group) structural equation.

satisfaction (β = 0.006, p 0.001, 95 % CI = [0.004, 0.008]). This indicates that deep collaboration among teachers may enhance job satisfaction indirectly by first promoting team innovation, which in turn strengthens teacher self-efficacy. H4 is supported. However, the effect size of this sequential pathway was relatively small (MP = 3.1 % 20 %), suggesting that the primary influence of teacher deep collaboration on job satisfaction stems from its direct effect rather than the chain mediation pathway. In this model, the explained variance for team innovation, self-efficacy, and job satisfaction at the teacher level was relatively low (R^2 = [0.046, 0.098]), possibly due to the multifactorial nature of job satisfaction, which may not be fully captured by the current model. Nevertheless, the central focus of this study lies in examining how teacher deep collaboration affects job satisfaction, rather than exploring all potential contributing factors. Overall, the standardized path coefficients indicate a well-fitted model, with all hypothesized relationships supported by the data, reflecting the structural robustness of the model. Detailed results for the teacher-level MSEM model are presented in Table 7.

6. Discussion

6.1. The positive impact of teacher deep collaboration on job satisfaction

This study first investigates the relationship between teacher deep collaboration and job satisfaction. Using teacher data from Shanghai in the TALIS 2018 dataset, the findings reveal that deep collaboration among teachers significantly enhances their job satisfaction. This result aligns with previous research (Duyar et al., 2013; Reeves et al., 2017; Sims, 2017; Toropova et al., 2021). While prior studies have recognized the imprecise use of the concept of teacher collaboration—particularly regarding its quality—they often lack efforts to further specify the construct (García-Martínez et al., 2021; Kolleck, 2019; Reeves et al., 2017; Ronfeldt et al., 2015; Vangrieken et al., 2015). By differentiating deep collaboration from the broader teacher collaboration framework, this study provides a preliminary structure for high-level collaborative models, thereby enhancing people's understanding of deep collaboration.

Moreover, the study proposes four key dimensions of job satisfaction—material, cultural, developmental, and self-worth—which can guide more comprehensive assessments in future research. Empirically, this study offers new evidence supporting the role of deep collaboration in improving teacher job satisfaction and addresses some of the conceptual limitations in existing collaboration research.

The positive relationship is consistent with the predictions of SCT (Bandura, 1986). Deep collaboration transforms the isolated nature of teachers' work into a more collective, interactive form, creating a fertile context for proactive behaviors and cognitive development, which in turn enhances job satisfaction. Collaborative teaching shifts teachers from isolated individuals to active members of a collective instructional unit, encouraging greater agency in professional practice. According to SCT, individuals' behavioral experiences shape their self-evaluations of competence, identity, and value (Bandura, 1997). Transitioning from individual to collaborative teaching can reduce instructional stress and broaden access to colleagues' expertise, thereby strengthening teachers' positive work perceptions. Effective collaboration also demands ongoing communication and feedback among teachers to achieve shared goals—this process of goal alignment and experience mastery promotes tighter team integration and higher levels of professional development. A key feature of deep collaboration is teachers' substantive engagement in teamwork rather than mere formal compliance (Forte & Flores, 2014; Goddard et al., 2007). Hence, collaboration training is necessary. Helping teachers develop interpersonal strategies—such as self-expression and mutual respect—enables more stable team functioning and enhances positive cognition in the collaborative process. Moreover, deep collaboration facilitates interdisciplinary and cross-domain exchanges. These forms of social learning contribute to stronger teacher identity construction, thereby reinforcing job satisfaction.

6.2. The mediating role of team innovation

The second research question of this study focuses on the mediating role of team innovation in the relationship between teacher deep collaboration and job satisfaction. The results indicate that deep collaboration not only has a direct positive effect on job satisfaction but also enhances it indirectly through team innovation. This finding is consistent with previous studies (Collie et al., 2012; Jiang & Chen, 2018) and clarifies the positive associations among teacher deep collaboration, team innovation, and job satisfaction. It further highlights the applicability of SCT in explaining how collaborative environments, innovation, and self-perceptions interact in educational settings, providing solid empirical support for future research.

Team innovation reflects teachers' willingness and proactive engagement in innovative practices. From the perspective of SCT, this orientation represents agentic self-regulation, where individuals exercise cognitive control and goal-directed behavior in response to their work environment (Bandura, 1986). Teachers' intention and engagement in innovation are positively associated with their outcome expectations—that is, the belief that their actions can result in meaningful instructional outcomes, professional growth, or recognition from the organization (e.g., from the teacher team; Yuan & Woodman, 2010). This sense of meaning is crucial for psychological fulfillment and contributes to an enhanced work experience and job satisfaction.

SCT also emphasizes the importance of environmental feedback in shaping behavioral motivation. Teachers' expectations of outcomes are influenced by social feedback such as peer input, student responses, and organizational culture. Here, teacher deep collaboration plays a crucial environmental role. It fosters a context in which teachers are brought

Table 7
Direct and indirect effects of teacher level variables.

Teacher Level	β	SE	Z	P	LLCI	ULCI	R^2	MP
Direct effects of TDC							**TDC**	
TDC → TI	0.214	0.021	10.303	***	0.173	0.255	–	
TDC→ TSE	0.196	0.016	11.923	***	0.164	0.229		
TDC→ TJS	0.087	0.018	4.75	***	0.051	0.124		
Direct effects of TI							**TI**	
TI→ TSE	0.199	0.017	11.953	***	0.166	0.232	4.6 %	
TI→ TJS	0.224	0.018	12.754	***	0.189	0.258		
Direct effects of TSE							**TSE**	
TSE→ TJS	0.119	0.017	7.116	***	0.086	0.152	9.5 %	
Indirect effects of TI and TSE							**TJS**	
TDC→ TI→ TJS	0.054	0.007	7.689	***	0.040	0.067	9.8 %	29.2 %
TDC→ TSE→ TJS	0.026	0.004	5.846	***	0.017	0.035		14.3 %
TDC→ TI→ TSE→ TJS	0.006	0.001	5.449	***	0.004	0.008		3.1 %

Note: we provide a 95 % confidence interval, MP = Mediation Proportion, R^2 = R-Square.

together to act as a collective, engage in collaborative training, participate in joint instructional activities, and exchange practice-based feedback. These processes promote deeper cognitive resource sharing and engagement. Consequently, teacher deep collaboration influences teachers' attitudes toward innovation and their innovative behavior, thereby improving job satisfaction.

6.3. The mediating effect of teacher self-efficacy and the chain mediation involving team innovation

The third and fourth research questions of this study focus on the mediating role of teacher self-efficacy in the relationship between teacher deep collaboration and job satisfaction, as well as the chain mediation of team innovation and teacher self-efficacy (TDC → TI → TSE → JS). The findings reveal that deep collaboration not only enhances job satisfaction through improved teacher self-efficacy but also influences self-efficacy via increased team innovation, thereby further contributing to job satisfaction. These results are consistent with previous research (Buske, 2018; Jiang & Chen, 2018; Khan & Gupta, 2024; Liu et al., 2023; Lopes & Oliveira, 2020; Reeves et al., 2017). This conclusion highlights how teacher self-efficacy is strengthened within collaborative contexts and its significant role in enhancing job satisfaction.

According to SCT, self-efficacy serves as a critical indicator of how individuals evaluate collaborative environments. Teacher deep collaboration, as a form of positive social context, offers two major sources for building self-efficacy: vicarious experience and verbal persuasion (Bandura, 1997). When teachers perceive themselves as capable of effectively supporting student growth, they are more likely to experience higher job satisfaction and form more positive evaluations of their own teaching performance (Liu et al., 2023; Toropova et al., 2021).

Another key finding is the chain mediating role of team innovation and teacher self-efficacy in the relationship between deep collaboration and job satisfaction. This pathway integrates teacher innovation into the SCT framework and provides a deeper understanding of the relationships among collaboration, innovation, efficacy, and satisfaction from an environment–behavior–cognition perspective. It also clarifies the mechanisms between innovation and self-efficacy of both the teacher team and individual teachers. In deep collaboration contexts, teacher cooperation and innovation are closely linked (McCharen et al., 2011; Roberts, 2000; Rubenstein et al., 2018). Collaborative teams offer multiple sources of social reinforcement—such as observational learning, mastery experiences, vicarious experiences, and social persuasion—that are essential for strengthening teacher self-efficacy (Bandura, 1997). These self-efficacy beliefs, in turn, foster more positive perceptions and experiences in both collaborative and instructional settings, ultimately enhancing job satisfaction (Bandura, 1997; Caprara et al., 2006; Toropova et al., 2021).

7. Limitations and future directions

This study investigated the mechanisms through which teacher deep collaboration influences job satisfaction, providing empirical support for promoting a shift toward deeper professional collaboration among teachers. Through empirical analysis, the study extends existing theoretical frameworks and proposes feasible educational practices. However, several limitations remain, which should be addressed in future research.

First, the cross-sectional nature of the data limits the ability to draw causal inferences. Although the TALIS 2018 cross-sectional dataset provides evidence for the relationship between teacher deep collaboration and job satisfaction, it does not permit strict causal interpretations and may affect the robustness of the mediation effects. Future studies could adopt longitudinal designs to track changes in collaborative practices over time, thereby examining the stability of the relationships and exploring the long-term impact of deep collaboration on teachers' job satisfaction.

Second, the theoretical and empirical basis for deep collaboration remains relatively underdeveloped. Although this study has identified several key characteristics of deep collaboration, its conceptualization still requires further refinement—particularly in light of potential transformations in teaching approaches and collaborative practices under the influence of digitalization. Moreover, the notion of collaboration may vary across different educational domains, and its application should be carefully contextualized to avoid potential issues (Jurkowski et al., 2023). Therefore, future studies should further enrich and contextualize theoretical frameworks of deep collaboration to accommodate various educational settings. In addition, this study did not examine potential moderators of the relationship between deep collaboration and job satisfaction. School-level factors such as leadership style and institutional support are known to have long-term impacts on teachers and hold substantial research value. Investigating how such factors moderate the effect of deep collaboration could enhance our understanding of its mechanisms and provide schools with more targeted intervention strategies.

Third, the operationalization of deep collaboration and job satisfaction requires further development and validation. There remains considerable conceptual confusion in the existing literature on teacher collaboration, especially regarding the distinction between superficial and deep forms of collaboration. This lack of clarity may lead to an underestimation of the actual impact of deep collaboration and result in misleading conclusions. Future research could refine measurement tools to distinguish between levels of collaboration and explore their respective impacts, thus improving our understanding of deep collaboration's unique role. In addition, although this study proposes a four-dimensional measurement framework for teacher job satisfaction, the empirical analysis was conducted using the TALIS 2018 dataset rather than primary data. The construction of job satisfaction in TALIS primarily reflects the survey's core focus at the time on teachers' working environment and professional identity—dimensions that this study categorizes as "cultural satisfaction" and "developmental satisfaction." Therefore, there is a certain discrepancy between the conceptual framework proposed in this study and the actual measurement, such as the absence of dimensions related to material satisfaction and self-worth satisfaction. Future research could build upon this framework to further enrich and refine the measurement of teacher job satisfaction or develop more comprehensive instruments to better capture the full range of teachers' work experiences and enhance both the explanatory power and practical relevance of related studies.

Finally, empirical research on deep collaboration faces challenges related to cost and methodology. As noted by several scholars and institutions, the current level of deep collaboration among teachers remains low and is notably different from shallow forms. In experimental studies, identifying stable experimental groups that demonstrate consistent deep collaboration, while matching them with control groups of similar demographic characteristics, remains a critical challenge. Similarly, longitudinal studies may encounter issues such as sample attrition, inconsistency in collaborative behavior, and high measurement error, all of which may affect the validity and generalizability of the findings. Future research should explore innovative research designs, data collection strategies, and methodological approaches to enhance the scientific rigor and credibility of findings in this domain.

In summary, while this study contributes to the theoretical and practical understanding of teacher deep collaboration, several limitations remain. Future research should further enhance causal inference, improve theoretical frameworks, refine operational definitions, and innovate in methodology. Such efforts will not only promote the development of deep collaboration but also help improve teacher job satisfaction and instructional quality, offering stronger theoretical and empirical support for educational reform.

CRediT authorship contribution statement

Haoran Ma: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Data curation. **Peng Liu:** Software, Formal analysis, Conceptualization. **Min Zhu:** Validation, Supervision, Resources. **Min Kang:** Writing – review & editing, Funding acquisition.

Informed consent statement

All participants provided informed consent before participating in the study. The anonymity and confidentiality of the participants were guaranteed, and participation was completely voluntary.

Ethical approval

All participants provided informed consent before participating in the study. The anonymity and confidentiality of the participants were guaranteed, and participation was completely voluntary.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT-4 to proofread the manuscript, focusing on correcting grammatical errors, checking spelling, enhancing clarity, refining sentence structure, and improving overall readability and coherence. After using this tool, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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Declaration of competing interest

The authors declare no conflict of interest.

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Appendix I. The Influencing Factors of Teacher Job Satisfaction

Teacher job satisfaction is shaped by a range of interacting elements, which can generally be categorized into three major domains: teacher-related factors, school-related factors, and societal-related factors. These factors collectively shape teachers' work experiences and determine their levels of satisfaction (Niu et al., 2023).

From the perspective of individual relevant factors, personal characteristics and psychological conditions play a direct role in shaping job satisfaction. For instance, novice teachers often encounter substantial work pressure and task overload during the transition into their professional roles. This may result in lower satisfaction and contribute to higher attrition rates (Amitai & Van Houtte, 2022). Excessive teaching workloads can also lead to what is termed time poverty, in which teachers lack sufficient time for professional development, personal life, or recovery. This condition may increase emotional exhaustion, diminish enthusiasm for teaching, and thereby reduce overall job satisfaction (Betoret, 2009; Zhu et al., 2025). Conversely, experiencing a sense of accomplishment in teaching has been consistently identified as a key contributor to satisfaction. Research has shown that when teachers observe positive learning outcomes and receive affirmative feedback from students, their teaching efficacy and job satisfaction improve significantly (Agyapong et al., 2022; Canrinus et al., 2012; Wang et al., 2022). Moreover, demographic characteristics such as gender, age, teaching subject, and professional experience have been widely explored in relation to teacher satisfaction (Crossman & Harris, 2006; Klassen & Chiu, 2010; Liu et al., 2021; Liu & Ramsey, 2008; Oliffe & Greaves, 2011; Sims, 2018). However, the findings across these studies remain inconsistent, likely due to the context-dependent nature of these demographic effects. The influence of such variables may differ under varying educational systems, regional circumstances, or cultural conditions. Thus, it is essential to interpret these factors in light of the specific educational context (Toropova et al., 2021).

From the perspective of school relevant factors, effective management and a positive organizational culture have been shown to exert substantial positive effects on teacher job satisfaction (Dou et al., 2017). For example, access to adequate material support—including instructional resources and working environments—can enhance both teacher well-being and satisfaction (Bascia & Rottmann, 2011; Zembylas & Papanastasiou, 2004). However, material compensation such as salary is not the only determining factor. Some studies suggest that teachers value the recognition of their efforts by the school more than monetary rewards (Perie, 1997; Perrachione et al., 2008). That said, the relative importance of financial incentives may vary across national and institutional contexts. In mainland China, for instance, salary levels and promotion systems are still reported as key determinants of job satisfaction (Guan et al., 2021; Li et al., 2017). Therefore, school-level strategies should ideally balance material incentives with psychological rewards—such as professional recognition and respect. Workload management also plays a crucial role. Reducing non-instructional duties can significantly relieve pressure on teachers (Skaalvik & Skaalvik, 2016; Toropova et al., 2021). A supportive school culture can promote collaborative practices, enhance teachers' sense of belonging, and strengthen their professional identity (Toropova et al., 2021; Xia et al., 2023). For example, increased instructional autonomy enables teachers to implement teaching strategies aligned with their educational philosophy, thereby reinforcing their sense of value and purpose (Skaalvik & Skaalvik, 2014). Furthermore, strong interpersonal relationships among colleagues can foster positive emotional experiences and improve overall job satisfaction (Da'as, 2021; Kılınç et al., 2024; Jacobsson et al., 2001).

From the perspective of social relevant factors, policy and the broader social environment also influence teacher satisfaction. Comprehensive welfare systems and stable employment policies can enhance teachers' sense of security and belonging, thereby boosting job satisfaction (Perie, 1997). When teachers' professional rights and interests—such as employment stability, retirement benefits, and career advancement opportunities—are protected, they are more likely to maintain high levels of satisfaction. In addition, teachers' engagement in positive social relationships—with colleagues, parents, and students—can help reduce occupational stress and mitigate the emotional burdens of teaching (Pepe et al., 2017). Social support, both formal and informal, not only relieves psychological strain (Zhu et al., 2025) but also enhances teachers' sense of well-being and satisfaction (Betoret, 2009; Fernet et al., 2013; Olsen & Huang, 2019).

Appendix II. The mapping between TALIS 2018 T3JOBSA and the four dimensions of job satisfaction

Items		Dimension	Rationale
1.TT3G53C*	I would like to change to another school if that were possible.	Cultural	Reflects dissatisfaction with the school's environment, leadership, or collegial culture.
2.TT3G53E	I enjoy working at this school.	Self-value	Indicates positive self-evaluation of teaching performance and professional competence.
3.TT3G53G	I would recommend this school as a good place to work.	Cultural/Material	Represents a general positive appraisal of the school, possibly encompassing culture and material resources.
4.TT3G53J	All in all, I am satisfied with my job.	Overall	A broad statement of job satisfaction, reflecting overall professional fulfillment.
5.TT3G53A	The advantages of being a teacher clearly outweigh the disadvantages.	Self-value	Demonstrates strong recognition of the professional role and its intrinsic rewards.
6.TT3G53B	If I could decide again, I would still choose to work as a teacher.	Developmental/Self-value	Combines long-term career commitment with personal value affirmation.
7.TT3G53D*	I regret that I decided to become a teacher.	Self-value	Signals identity dissonance and lack of goal fulfillment.
8.TT3G53F*	I wonder whether it would have been better to choose another profession.	Self-value	Shows doubt about current career choice and diminished occupational identity.

Note: The TALIS 2018 survey tends to assess teachers' overall level of job satisfaction, whereas the four-dimensional framework proposed in this study offers a more detailed conceptualization of the construct. Accordingly, the job satisfaction items in TALIS may correspond to one or multiple dimensions simultaneously, rather than exhibiting a strict one-to-one mapping.

Data availability

The data is publicly available.

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