

The role of teachers' participation in professional growth: a comprehensive systematic review

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ABSTRACT

This systematic literature review explores the dynamics of teacher participation in professional development and identifies key factors contributing to the enhancement of teaching competencies and professional identity. While the importance of reflective and sustained engagement is acknowledged, the specific mechanisms linking active involvement to enhanced teaching competencies have not been adequately analyzed. To address this, a comprehensive search was conducted across reputable academic databases. These include Scopus, Web of Science (WoS), and ERIC, targeting studies published between 2020 and 2026. The review process followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodology, encompassing stages of identification, screening, eligibility, and inclusion. Using a retrieval of 7,847 records, 60 peer-reviewed articles were selected based on language, relevance, publication type, and thematic scope. A two-stage selection was used, combining abstract-level lexical warrants with full-text coding against a single analytical scaffold collaborative-agency/identity/efficacy-ecology (CAE-8). The findings reveal three themes: i) collaborative professional learning designs (C1-C3); ii) teacher agency and identity (A4-A6); and iii) the influence of external factors on teacher competencies (E7-E8). The conclusion emphasizes that sustained and meaningful participation in context-sensitive professional development environments is essential for cultivating adaptive and competent educators. This review synthesizes existing research and offers actionable insights and practical recommendations for educational systems to implement strategic support mechanisms.

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1. INTRODUCTION

Teacher participation in professional growth plays a pivotal role in advancing educational transformation and facilitating the effective implementation of instructional reforms [1]–[3]. In addition to skills acquisition, contemporary reforms increasingly require teachers' sustained engagement in ongoing teaching and learning improvement. Teachers are central agents in shaping the pedagogical culture, influencing students' outcomes, and driving institutional development [4]–[6]. Professional development—grounded in individual initiative and collaboration, and emblematic of continuous learning—sits at the heart of renewing pedagogical norms and raising educational standards at the individual and institutional levels [7], [8]. By positioning teachers as central agents, active participation becomes critical to their own professional

growth and to achieving wider systemic goals [9], [10]. Building on this perspective, the present systematic review provides a novel synthesis of evidence about professional learning communities (PLCs) design conditions, stage-sensitive trajectories of agency, identity, and self-efficacy, as well as macro-level contextual influence on professional growth, with particular attention to accountability-heavy, resource-constrained contexts, including Chinese independent colleges.

Professional development involves reflective inquiry, experiential learning, and collaborative engagement [11], [12]. It is achieved through ongoing, well-designed, context-sensitive learning experiences. These experiences respond to teachers' needs, align with professional requirements, and consider local educational contexts. They are shaped by both personal motivation and organizational commitment. Development involves more than acquiring or expanding knowledge. It includes changes in instructional beliefs, classroom practices, and professional identities over time. Teachers' participation is an essential element of this development. It typically occurs in supportive environments such as PLCs, lesson study groups, peer mentoring programs, and other inquiry-based models [13]–[16]. Participation involves more than attending a training event. It entails active participation, critical self-reflection, and a commitment to transformative practices and improvements.

Several studies have shown that active participation in the classroom is associated with pedagogical quality, instructional confidence, and self-efficacy. It also supports student engagement and achievement [17]–[19]. Participation helps build a learning responsibility and may foster collegial learning cultures where members are reflective. This, in turn, will enhance student engagement, academic motivation, and performance [20]. Participation at all organizational levels can drive change when teachers share a vision and work together in supportive working groups [21]. However, teachers face competing demands from policy mandates, administrative expectations, and accountability pressures daily. They must innovate and pursue personal development despite daily classroom pressures and the challenges of professional participation [22]. This tension may be exacerbated by time constraints and a lack of systemic support [23]. Top-down, generic professional development programs that are not classroom-based and lack sustainability [24]. Sustained support is therefore necessary. It should be sensitive to diverse contexts and involve long-term programs that clarify expectations and encourage meaningful participation [11], [25].

Scholars and policy makers emphasize the importance of comprehensive, context-sensitive approaches to teacher learning that place the participant at the center [26], [27]. In such interventions, content matches subject matter, and career stage training is provided. Peer-based structures (such as peer learning communities, lesson study communities, and mentoring communities) enable collaborative inquiry, reflection on practice, and professional dialogue. These support lifelong learning in ways that are cost-effective and close to classrooms. A well-designed PLC can overcome development obstacles and build trust, commitment, and positive feelings among teachers [28]. However, the application of these principles varies in practice. Where resources are limited, few collaborative structures are established or sustained. As a result, opportunities for low-stakes experimentation, as well as for the development of teacher agency and identity, are often constrained [29], [30].

As a pillar of professional growth, teacher agency is defined as the capacity to act with intentionality and choice. When teachers learn within their real teaching worlds, their agency is at its most pronounced [31], [32]. Teacher's identity, which encompasses their beliefs, routines and behaviors is shaped by institutional culture and how they interact with colleagues [33], [34]. A teacher's identity determines how he or she captures opportunities for improvement. However, accountability regimes, evaluations per se (especially in Chinese higher education), and workshop attendance patterns reduce teacher agency by restricting what teachers can choose to learn from, particularly when professional development programs are distance-based. There seems to be a challenge for all teachers in complying with this item. Furthermore, in contexts such as South Africa and Indonesia, the lack of formal mentorship has resulted in informal support systems with variable effectiveness [35]–[38].

This study explores the multifaceted nature of teacher participation in professional growth and its broader implications for instructional quality and institutional capacity. In a context of rapid technological change, curricular reform, and shifting societal expectations, sustained and context-responsive professional learning is increasingly important. This study focuses on teachers' active participation and has three aims: i) identifying effective PLC strategies; ii) examining the development of agency, identity, and self-efficacy; and iii) exploring how external factors shape professional growth [39], [40]. Real engagement entails not only the contextual adaptation of policy innovations but also the formation of collaborative networks and the enactment of practice-embedded change [41], [42]. Accordingly, this study examines how teacher participation can be cultivated and sustained to underpin adaptive, equitable, and resilient education systems [43].

Despite extensive work on teacher professional learning, three gaps persist. First, the literature privileges kindergarten through grade 12 (K-12) and research-intensive universities. It gives comparatively little attention to China's teaching-oriented independent colleges. In these settings, audit-driven evaluation and resource constraints distinctly influence participation in and the design and uptake of PLCs. Second, participation is often defined as mere attendance. This leaves underexplored how teachers' agency, identity,

and self-efficacy evolve over time. Third, evidence on actionable, low-cost strategies for peer-led PLCs in accountability-heavy contexts remains thin. Longitudinal accounts that incorporate macro-level contingencies, including policy reforms, economic pressures, and pandemics, are also rare.

This systematic review is unique, making three contributions. First, it integrates three strands within a single analytic scaffold collaborative-agency/identity/efficacy-ecology (CAE)-8: i) design conditions of PLC-type structures; ii) stage-sensitive trajectories of teacher agency, identity, and self-efficacy; and iii) macro-level contingencies. It also foregrounds accountability-heavy, resource-constrained contexts, including Chinese independent colleges that are underrepresented in prior reviews. Second, the review adopts a transparent, two-stage selection logic. It distinguishes between mere attendance and participatory mechanisms that translate into enacted professional growth. The study follows a pre-specified, preferred reporting items for systematic reviews and meta-analyses (PRISMA)-consistent protocol for search, screening, and critical appraisal, and draws on both international and Chinese databases. Third, the review provides clear outputs. It develops an evidence map, identifies actionable and low-cost PLC design principles, proposes a stage-sensitive model of professional growth, and outlines a targeted research agenda. To our knowledge, no prior review has jointly specified when (under which accountability/ecology conditions) and how (through A4-A6 mechanisms: agency, identity, and self-efficacy) PLC-related designs lead to teacher growth. This is especially relevant in contexts where mentoring and digital infrastructures are uneven.

2. METHOD

This systematic literature review or SLR was conducted in accordance with PRISMA framework [44]. The review process adhered to the four PRISMA phases—identification, screening, eligibility, and inclusion—as illustrated in Figure 1. The review was guided by three research questions (RQ1-RQ3): i) RQ1: what are the most effective strategies for fostering PLCs that enhance teacher growth? ii) RQ2: how do teachers' agency, identity, and self-efficacy evolve through different stages of their professional growth? and iii) RQ3: how do external factors such as policy shifts, economic conditions, and pandemics influence teachers' professional growth and competencies?

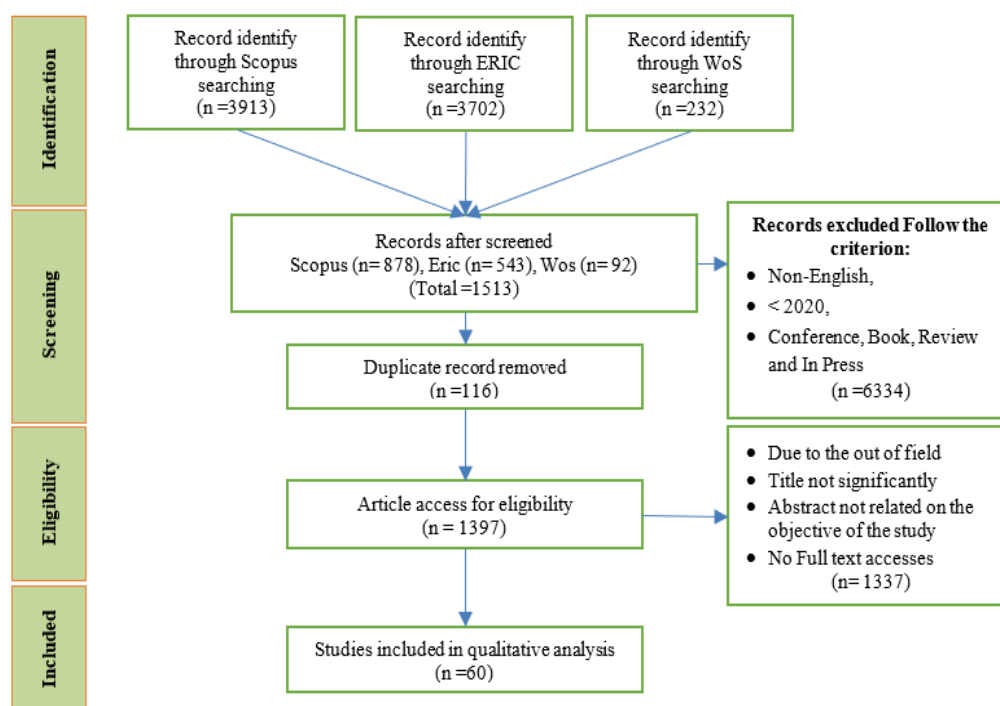


Figure 1. PRISMA diagram of the propose searching study

2.1. Identification

The systematic review process employs four primary stages to identify and select relevant publications for this study. It begins with the identification of key terms and related concepts, informed by

thesauri, dictionaries, encyclopedias, and prior research. Consequently, search strings on Scopus, ERIC, and Web of Science (WoS) database have been developed once all pertinent terms have been determined. In total, 7,847 records were initially retrieved from all three databases. Guided by the research questions, three core keywords were identified: “teacher”, “participation”, and “professional growth”. To enhance the comprehensiveness of the search, related terms and synonyms are identified using an online thesaurus and through consultation with an education expert. This refinement results in additional keywords such as “educator”, “engagement”, “involvement”, “teaching development”, “competency building” and “guided learning”. Expanding the range of keywords and search terms enhanced the breadth of the literature search, thereby improving its comprehensiveness and ensuring the inclusion of all relevant articles. Table 1 presents the finalized search strings used for all the databases.

Table 1. The search strings and keywords used for systematic review process

Database	Search string
Scopus	TITLE-ABS-KEY (“teacher” OR “educator”) AND (“participation” OR “engagement”) AND (“professional growth”) AND PUBYEAR > 2019 AND PUBYEAR < 2027 AND (LIMIT-TO (SUBJAREA , “SOC”)) AND (LIMIT-TO (DOCTYPE , “ar”)) AND (LIMIT-TO (LANGUAGE , “English”)) AND (LIMIT-TO (SRCTYPE , “j”)) AND (LIMIT-TO (OA , “all”)) AND (LIMIT-TO (PUBSTAGE , “final”)) Date of Access: Mar 2026
ERIC	(“teacher” OR “educator”) AND (“participation” OR “engagement”) AND (“professional growth”) Publication Type: Journal Articles Publication Date: 2020–2026 Date of Access: Mar 2026
WoS	(TS=“teacher” OR TS=“educator”) AND (TS=“participation” OR TS=“engagement”) AND (TS=“professional growth”) (All Fields) and Open Access and 2026 or 2025 or 2024 or 2023 or 2022 or 2021 or 2020 (Publication Years) and Article (Document Types) and English (Languages) and All Open Access (Open Access) Date of Access: Mar 2026

2.2. Screening

During the screening phase, the collection of potentially relevant research items is assessed for their alignment with the predefined research questions. Content-related criteria applied during this phase primarily involve selecting studies that specifically addressed the role of teachers’ participation in professional growth. At this stage, all duplicate papers are eliminated from the search results. During the initial screening phase, 6334 publications were excluded, followed by a detailed review of 1513 papers in the second phase based on the study’s predefined inclusion and exclusion criteria as in Table 2. The primary inclusion criterion was literature (research papers), as it serves as the principal source of practical insights and recommendations. Other sources such as reviews, meta-syntheses, meta-analyses, books, book chapters, and conference proceedings were excluded if they had been addressed in the latest study. Additionally, the review was limited to English-language publications from the years 2020-2026. A total of 116 publication was removed due to duplication.

Table 2. Inclusion and exclusion criteria involved in the screening process

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2020-2026	<2020
Literature type	Journal (article)	Besides journal (article)
Publication stage	Final	In press
Subject area	Social sciences	Besides social sciences
Article requirement	Scope of research fulfils the RQs	Scope of study does not fulfil RQs

2.3. Eligibility

In the third phase, referred to as the eligibility assessment, a total of 1397 articles were compiled for detailed evaluation. During this stage, each article’s title and core content were meticulously reviewed to ensure their alignment with the inclusion criteria and relevance to the study’s research objectives. Consequently, 1337 articles were excluded for being outside the study’s scope, that were not significantly relevant, having abstracts unrelated to the study’s objectives, or lacking full-text access. Ultimately, 60 articles remain for inclusion in the subsequent review.

2.4. Data abstraction and analysis

We conducted an integrative synthesis across qualitative, quantitative, and mixed-methods studies. 60 records met the inclusion criteria and were analysed using a two-stage procedure to enhance transparency

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and reproducibility: abstract-level lexical screening and theory-anchored full-text coding. This analytic process employed a hybrid deductive-inductive approach. It combined predefined lexical term families and the CAE-8 analytic scaffold with the inductive identification of emergent subthemes and cross-study patterns. The corresponding author coordinated the analytic workflow and consolidation of the thematic structure.

Stage 1 is lexical screening. Abstracts were screened using three predefined term families: i) collaborative professional learning structures—professional learning community (PLC), community of practice (CoP), professional learning network (PLN), teacher learning community (TLC), lesson study, mentoring, coaching (any of these terms); ii) teacher agency, identity, self-efficacy; and iii) ecological or accountability contexts (e.g., policy, reform, pandemic, COVID-19, resource constraints, and national context) (any of these terms). Normalization rules addressed orthographic variants (e.g., self-efficacy/self-efficacy). This process generated a traceable inclusion warrant prior to interpretive coding. Stage 2 is theory-anchored coding. We applied the CAE-8 framework, which organizes analysis into three blocks (C, A, and E) and eight subdimensions (C1-C3, A4-A6, and E7-E8). This scaffold enabled consistent and comparable coding across studies while linking structural designs (C), person-level mechanisms (A), and ecological conditions (E).

Two coders co-developed an a priori codebook (definitions; inclusion and exclusion criteria; positive and negative indicators) and piloted it on 10% of the corpus. A recode map was used to harmonize legacy terms (e.g., mapping LS to lesson study and PLCs to PLC). Coding was then conducted independently by two coders using a shared extraction sheet. Discrepancies were resolved through iterative consensus discussions, with expert adjudication where necessary. An audit trail documented coding decisions, revisions, and analytical reflections to ensure transparency and consistency.

Data analysis combined descriptive and thematic techniques. We quantified code presence by sub-dimension and produced frequency distributions and cross-tabulations by period, setting (pre- and in-service; subject area), and structure type (e.g., PLC, CoP, PLN, TLC, lesson study, mentoring, and coaching). A framework-guided synthesis was then conducted to link collaborative designs (C) with person-level mechanisms (A) under varying ecological conditions (E). To address common themes, patterns, and recurrent problems, we applied a two-step contrastive procedure: within-corpus convergence mapping to identify cross-study themes and recurrent C×A×E linkages and comparison with prior reviews to identify divergences and underexplored areas. Findings are reported in the results and discussion section.

2.5. Quality appraisal

The authors collected 60 studies and two experts having an in-depth practice in the educational institution were asked to provide reviews and validation of these articles. This study documents how the use of the critical appraisal skills programme (CASP) checklist is fundamental in a systematic review process [45], [46]. The quality of the studies was measured by two experts in the educational field with over ten years of experience in schools. Checklists were used to give structured directions for appraising the research and its evidence quality [47]. The whole evaluation process was based on the three grade criteria: “excellent”, “good”, and “moderate” for the quality of the study. Each contribution was checked from several points of view, like the clarity of the research aim, the methodological and design diligence, the recruitment strategy appropriateness, the quality of the data collection and analysis, the manifestation of the findings, and finally the contribution. Experts on teaching English as a second language (TESL) and education reviewed the themes to ensure their reliability. Each subtheme was reviewed for clarity, relevance, and detail, and their role focused on domain validity.

3. RESULTS AND DISCUSSION

Three major themes were identified in this study. The first theme concerns teachers’ continuous professional development through learning communities. The second theme focuses on teacher agency, identity, and self-efficacy in relation to professional development, while the third examines external factors that influence teachers’ professional development and competence.

3.1. Teacher professional development (TPD) and learning communities

The 21 studies have shown a positive association between teachers’ professional growth and collaborative, practice-integrated professional development programs. Consistent with core implementation science dimensions—namely, tracking the effectiveness of improvement strategies in real-world settings—we organize our findings around three implementation components: i) C1 supportive conditions; ii) C2 participation and facilitation; and iii) C3 results orientation and shared repertoires. Recent thirteen studies further demonstrate that the effectiveness of such collaborative professional development structures depends on the operationalization of key conditions and shared norms within professional communities, rather than their mere existence.

3.1.1. Supportive conditions (CAE-8: C1)

Participation is enhanced when structures such as time, facilitation, explicit scaffolds, and multi-stakeholder alignment are put in place. An integrated virtual professional development program combined synchronous and asynchronous engagement. It also provided explicit tool instruction and collaboration scaffolds, which supported teacher learning in computational thinking contexts [48]. Research-practice partnerships (RPPs) aligned stakeholders and provided regular support. They also revealed scalability challenges in introducing updated CS curricula, illustrating how institutional arrangements shape participation [49]. Similarly, research on PLCs highlights that clearly defined norms, shared goals, and structured collaboration routines are essential for sustaining teacher learning in everyday practice [50]. Longitudinal evidence further shows that goal interdependence and leadership-supported vision building significantly enhance teachers' engagement in collaborative learning activities over time. It reinforces the importance of organizational conditions [51].

3.1.2. Participation and facilitation (CAE-8: C2)

Teachers' growth was closely linked to practice-integrated participation routines. Coached workshops increased teachers' self-efficacy in language-supportive areas more than workshops alone. This demonstrates the value of individualized, practice-based support [52]. In a crisis, CoPs served as support communities that helped English as a foreign language (EFL) teachers solve online teaching problems and maintain professional exchanges [53]. Outside school, Twitter PLNs provided a venue for professional discussions and social support for Higher Education (HE) learning designers [54]. Mentoring was a key practice, as it enabled the transfer of tacit knowledge to novice teachers by means of job crafting (i.e., teacher-driven modification of tasks) [55]. In addition, constructivist mentoring programs provide sustained opportunities for peer interaction, reflection, and bottom-up knowledge construction. These opportunities strengthen teachers' engagement in professional learning processes [56]. Evidence from community-based learning contexts also suggests that regular interaction, shared experiences, and relational support within communities of practice facilitate knowledge exchange and professional growth [57].

3.1.3. Results orientation and shared repertoires (CAE-8: C3)

Teachers' perceptions of their ability to support students in developing self-regulated learning (SRL) skills improved as a result of online TPD on SRL content [58]. During placements, professional development, mentoring, and on-the-job learning were linked to a variety of outcomes and practice intentions at the classroom, collegial, and school levels. This illustrates how shared routines are translated into shared practices or targeted actions [59]. Similarly, lesson study has been shown to contribute to the development of professional school culture and teacher self-efficacy, indicating that collaborative routines can be transformed into sustained professional practices [60].

In sum, professional development formats that incorporate enabling conditions and participation routines (CAE-8: C1-C3) consistently lead to capability and agency gains (A6/A4). They also support tacit knowledge transfer in mentoring arrangements, even when time and resources are limited. According to our sample, these patterns of insights align with previous lesson study results and research on teacher agency and continuing professional development (e.g., [28], [29], [61]), forecasting capability dynamics in Section 3.2. and contextual dispositions in Section 3.3. These findings further confirm that structured collaboration functions as a mechanism for professional learning. When effectively facilitated and supported, it helps stabilize learning and translate it into practice.

3.2. Teacher agency, identity, and self-efficacy in professional growth

We organized findings around three CAE-8 subdimensions: A4 agency, A5 identity, and A6 self-efficacy. Data revealed that these capacities contributed to teachers' professional growth. They also supported co-participative practices within collaborative professional learning contexts.

3.2.1. Agency (CAE-8: A4)

Agency is enacted through projective intentions and the practical adoption of practices in daily work. Mentoring facilitates the transfer of tacit knowledge by connecting supportive guidance with concrete workplace enactment, thereby exemplifying the leverage of practical agency [55]. For work-placement professional development programs, teachers reported positive intentions at the classroom, college, and school levels. These provide evidence that practices extended beyond individual and classroom settings [59]. Despite capability gaps, cross-disciplinary novices expressed agency through internal strategies, such as motivation and attitude, or through outside supports, such as research internships and course assignments. This reflects the early-career agency shaped using available supports and coping behaviors [62]. Agency is

closely associated with autonomy perceptions among teacher educators working in contexts of volatility and uncertainty [63]. This suggests that agency is realized through dynamic engagement within CoPs under volatile, uncertain, complex, and ambiguous (VUCA) conditions. Recent evidence also shows that professional agency develops through teachers' capacity to interpret classroom interaction. It also develops using peers, experienced teachers, and students as resources for learning [64].

3.2.2. Identity (CAE-8: A5)

Identity was multifaceted and context-sensitive among participants. Cross-disciplinary novices, in particular, sought to construct a professional identity while simultaneously confronting inadequate preparation or low self-efficacy. These identity-related claims were often reinforced by the opportunity structures and enhanced visibility afforded through professional development offerings [62]. Geography educators reported that their professional identities emerged from personal, professional, and social life agendas. These agendas were negotiated within communities of practice and in contexts affected by volatility [63]. Work-placement CPD fostered teachers' professional identity development by facilitating authentic interactions with learners and workplace practices. These interactions strengthened teachers' role conceptions and sense of professional belonging [59]. Similarly, identity development has been described as an evolving process shaped by professional transitions, institutional conditions, and teachers' participation in new reform-oriented settings [65].

3.2.3. Self-efficacy (CAE-8: A6)

Targeted engagement bolstered self-efficacy. Coaching-augmented workshops were more effective than workshops in isolation. They enhanced teachers' self-belief in supporting students' language learning [52]. Online TPD centered on SRL-enriched knowledge and perceived skills in student SRL coaching [58]. The teacher attitudes and beliefs in computer science scale demonstrated robustness and a sound factor structure. It was used to assess teachers' self-beliefs, learning orientations, and related constructs. This enabled a nuanced analysis of how such predispositions facilitate or inhibit practice across teacher groups [66]. Cross-disciplinary novices showed lower initial self-efficacy than their counterparts. They required scaffolded experiences to translate identity aspirations into confident enactment [62]. Work-placement CPD further showed that enactment and confidence varied depending on the alignment between learning events and teaching contexts [59]. Further evidence suggests that collaborative inquiry through lesson study can strengthen teachers' self-efficacy, especially when participation is supported by collegial interaction and favorable school conditions [60].

In summary, the A-dimension evidence indicates that participation routines play a key role in teacher development. These routines include mentoring and coaching, work placements, and CoPs or PLNs. They cultivate practical-evaluative agency, role-secure identities, and task-specific self-efficacy. These capacities are mutually reinforcing and condition how the C-block architectures reported in Section 3.1. translate into enacted change, while remaining sensitive to contextual constraints developed in Section 3.3.

3.3. The impact of external factors on teacher development and competencies

External contingencies shaped both the form of professional learning and how participation translated into competencies. We organize the results using the CAE-8 framework. Specifically, we focus on E7 (accountability and institutional arrangements) and E8 (disruptions and technological, environmental shocks). We then indicate how these forces condition the C- and A-dimensions discussed in Sections 3.1. and 3.2.

3.3.1. Accountability and institutional arrangements (CAE-8: E7)

RPPs involved multiple stakeholders and provided sustained support. They also revealed scalability issues when introducing new computer science (CS) curricula. These findings show how governance, roles, and coordination can enable or constrain professional development structures (C1) and the enactment of professional development (C2/C3) in context [49]. This aligns with policy-oriented analyses. These studies show that large-scale certification systems and governance frameworks shape teacher development trajectories and define participation conditions within professional development systems [67]. Work-placement CPD institutionalized school-industry collaborations. It was associated with a range of learning outcomes and practice intentions at the classroom, collegial, and school levels. This shows how organizational design can secure professional development beyond the individual classroom [59]. China's policy responses to teacher shortages introduced a new degree pathway for cross-disciplinary candidates. This expanded the teacher supply but also revealed identity tensions and lower self-efficacy among newly recruited teachers. These findings show how macro-level policy directs professional trajectories and creates the need for targeted scaffolding [62]. At the same time, policy-driven professional development may function as an instrument of external control. It can shape teachers' practices and limit local adaptation, revealing tensions between standardization and professional autonomy [68].

3.3.2. Disruptions and technological, environmental shocks (CAE-8: E8)

Field shocks, such as the COVID-19-induced shift to online teaching and rapid digitization, reconfigured professional development mechanisms. They also reshaped the conditions for participation. Research on digital transformation indicates that the increasing integration of internet technologies reshapes instructional practices and creates new forms of professional learning environments. This, in turn, redefines how teachers engage in knowledge construction and collaboration [69]. Online communities of practice served as support networks for EFL teachers during crisis conditions. They helped teachers address challenges in online teaching, sustain professional exchange, reduce isolation, and maintain collegial learning [53]. Purpose-designed virtual professional development combined synchronous and asynchronous engagement with explicit tool instruction and coaching. This enhanced teachers' capacity to integrate computational thinking into their practice. Field shocks can also generate new design pathways with lasting value [48]. Twitter-based PLNs afforded ongoing professional conversation and social support among higher-education learning designers, extending access beyond institutional boundaries [54]. Online TPD focused on SRL significantly enhanced teachers' perceptions of knowledge and skills regarding fostering student SRL, suggesting possibilities for targeting result-based online programs for competency gains [58].

To summarize, E7 and E8 explain how collaborative designs as discussed in Section 3.1. translate into capacity shifts as in Section 3.2. E7 configures organizational scaffolds and scaling paths, such as RPPs, workplace CPDs, and revised degree pathways. E8 accelerates the transition to virtual CoPs, PLNs, and content-focused TPDs. When supportive structures and performance goals are salient, external pressures can disrupt existing mechanisms. They may also shift enactment towards the development of competencies through digital channels.

3.4. Discussion

According to these findings, teachers are the principal contributors to their own professional development. Collaborative architectures (C) influence change through agency, identity, and self-efficacy (A), while their outcomes are further shaped by accountability regimes and macro-level contexts (E). This framework helps clarify what works, as well as when and why it works.

First, we discuss C1-C3 (designs, routines, and repertoires). Across the corpus, professional gains are most consistently observed when key conditions are aligned. These include enabling conditions, such as protected time, facilitative leadership, and purposeful data use, as well as participation and facilitation routines (e.g., coaching, mentoring, peer observation, and structured dialogue). They are further supported by results orientation and shared repertoires, including clearly specified outcomes, shared artefacts, and language-in-use. When any element is weak—such as short-lived initiatives lacking protected time, or workshop-based activities without follow-up coaching—the effects tend to attenuate. This pattern is consistent with prior evidence. Relational and infrastructural barriers reduce PLC engagement [28]. Implementation inconsistency undermines lesson study in under-resourced systems [29]. Institutional trust and localized support are preconditions for collaborative structures to consolidate professional identity [30]. Overall, design, routine, and repertoire function as a bundle rather than isolated features [28], [29], [61]. This is also reflected in comprehensive PLC operationalization frameworks, which emphasize the interdependence of structural and interactional elements [50].

Second, we focus on A4-A6 mechanisms. Participation translates into growth through three key processes. These include practical-evaluative agency, role-secure identity, and task-specific self-efficacy. Intentional design that couples identity support with practice-embedded participation strengthens these pathways. This is shown in the Vietnamese Teacher Activity Groups (TAG) study [70] and in Alonso-Prieto *et al.* [71]. Early-career identity construction depends on mentorship, structured reflection, and institutional empathy [72]. More broadly, agency enables reflective practice and sustained engagement. However, digital inequalities during the pandemic compounded participation barriers [61]. This has reinforced calls for models that bridge intrinsic motivation and external policy or infrastructure [73]. Evidence from China likewise suggests that teacher-led goal-setting, constructive feedback, and collegial interaction enhance engagement and identity [15], [30].

Third, we focus on E7-E8 conditions and shocks. E7 includes accountability intensity, workload, evaluation regimes, and organizational routines. It determines whether C1-C3 can be designed, scaled, and sustained. Such policy-driven arrangements may simultaneously enable coordination but also generate tensions between external expectations and local practice [68]. E8 includes pandemics, rapid digitalization, and policy shifts. These forces have a dual effect. They reshape pedagogical practices and interaction patterns through digital mediation, requiring new forms of professional adaptation and learning [69]. And it can also disrupt participation or re-route it into virtual PLCs, CoPs, PLNs, and outcome-focused online TPD. When designs are explicit, and repertoires are shared, these shifts can lead to competence gains [28]–[30], [61]. Whether shocks become catalysts or constraints depends on trust, local support, and equitable access.

Designing for the C1-C3 bundle requires several key actions. Collaborative time should be protected, facilitative roles should be appointed, and participation should be structured through observation, debrief, and artefact use. Outcomes and shared repertoires also need to be clearly specified. Evidence from PLCs, lesson study, and technology-enabled TLCs suggests that these features can transfer across contexts [28], [29], [61]. Designing for the A4-A6 mechanisms also involves specific strategies. Workshops should be coupled with sustained coaching and mentoring. Teachers should be allowed to choose goals and artefacts to strengthen agency and identity. Routine tracking of task-specific self-efficacy is also important [15], [61], [70]–[72]. At the contextual layer, roles and resourcing should be aligned in research-practice partnership-type arrangements. Virtual PLCs and PLNs can be leveraged when resources are limited. Light-weight routines, such as short cycles and micro-artefacts, help maintain momentum under time pressure [15], [61].

Digital inequities and uneven mentoring infrastructures limit participation opportunities in accountability-heavy settings. These constraints often interact and reinforce each other. Targeted supports are therefore needed to ensure equitable uptake. These include time-banking, low-bandwidth options, local facilitation capacity, and novice-specific scaffolds [15], [24]. Several evidence gaps also remain. Firstly, construct conflation across PLC, CoP, and PLN labels. Second, measurement remains heterogeneous for agency, identity, and self-efficacy. Third, many studies are short in duration and provide limited reporting of implementation fidelity. Fourth, E7 and E8 dimensions are often under-specified in methodological descriptions. Addressing these issues would improve comparability and transferability. This is particularly important for independent colleges and other resource-constrained contexts.

3.5. Cross-study synthesis (RQ3): common themes, patterns, and recurrent problems

This cross-study synthesis explicitly answers RQ3. It integrates cross-study regularities and links earlier design features with person-level mechanisms and contextual conditions. Three common themes emerge. These themes are not independent but interact dynamically. This indicates that professional development outcomes emerge from the alignment between structural designs, individual capacities, and contextual conditions, rather than from any single factor alone. Recent research further supports this view. Professional development is most effective when learning experiences, reflective processes, and contextual supports are integrated rather than implemented as isolated components [74].

First, C1-C3 operate as a bundle. Participation is more likely to translate into uptake and transfer when key conditions are aligned. These include protected time (C1) and facilitative participation routines such as coaching, mentoring, peer observation, and structured dialogue (C2). They are further supported by results orientation and shared repertoires (C3) across PLCs, lesson study, and technology-enabled TLCs. This is consistent with recent evidence showing that structured online professional development, combined with collaborative analysis and continuous support, leads to measurable improvements in instructional practices and student learning outcomes [75]. Second, A4-A6 function as the core mechanisms. Practical-evaluative agency (A4), role-secure identity (A5), and task-specific self-efficacy (A6) reinforce one another. Together, they mediate how collaborative designs translate into enacted change. Third, ecology matters. Institutional arrangements captured by E7, such as research–practice partnerships and work-placement school–industry links, make participation durable and scalable. Shocks and digitalization captured by E8 reconfigure participation toward virtual PLCs, PLNs and outcome-focused online TPD. When designs are explicit and access is equitable, these shifts may produce measurable competence gains rather than disruption. In summary, the effectiveness of professional development depends on coherence across C-, A-, and E-dimensions. This highlights the importance of integrated design rather than isolated interventions.

Recurrent problems were also observed across the data. Construct conflation is common. PLC, CoP, and PLN labels are often used interchangeably, and attendance or activity is frequently treated as a proxy for genuine participation. Measurement also remains heterogeneous. Indicators for agency, identity, and self-efficacy (A4-A6) lack shared definitions and validated instruments. This limits comparability and cumulative knowledge building. Many interventions are short and provide weak reporting of implementation fidelity. Follow-up is often limited, and information on cost is rarely provided. Contextual constraints and inequities persist. Time pressure, resource scarcity, hierarchical cultures, and uneven mentoring infrastructures depress participation. Digital divides also produce unequal access and engagement in online formats. Importantly, similar professional development models may produce divergent outcomes under different contextual constraints. This further underscores the role of ecological factors. Recent studies also show that institutional governance structures, workload pressures, and evaluation systems can reshape teachers' engagement and limit the sustainability of professional development outcomes [76]. Overall, these themes triangulate Sections 3.1. and 3.4. and directly answer RQ3. They specify which designs work (C1-C3 as a bundle), through which person-level mechanisms (A4-A6), and under which contextual conditions (E7-E8) professional development is most likely to produce durable growth.

4. CONCLUSION

This systematic review clarifies how teachers' participation in collaborative professional learning translates into capacity gains and the conditions under which these gains can be sustained. Using the CAE-8 framework, the review integrates collaborative designs (C), person-level mechanisms (A), and contextual conditions (E) within a unified analytic frame. The findings indicate that effective professional development depends on the alignment of three dimensions: bundled collaborative structures (C1-C3), person-centred mechanisms of agency, identity, and self-efficacy (A4-A6), and enabling contextual conditions (E7-E8). In sum, these dimensions explain how participation moves beyond attendance and becomes sustained professional growth.

Theoretically, this study refines and applies a mechanism-oriented and context-sensitive analytic scaffold (CAE-8) that improves conceptual clarity and comparability across studies. It also contributes to contextual theory by highlighting resource-constrained and accountability-intensive settings as important boundary conditions, particularly in underrepresented contexts such as China's teaching-oriented independent colleges. Practically, the findings suggest that institutions should protect collaborative time, assign facilitative roles, combine workshops with sustained coaching and mentoring, and leverage virtual PLCs and PLNs where resources are limited. Designing professional development to be personal, participatory, and reflective improves uptake and transfer under time and resource constraints.

This review has several limitations, including uneven evidence in duration, measurement, and fidelity reporting, as well as conceptual overlap among PLC, CoP, and PLN labels. Overall, the review positions teacher learning as a personal, participatory, and contextually situated process. Future research should prioritize accountability-intensive and resource-constrained contexts, including independent colleges, and focus on interdisciplinary transitions and novice teachers with strong identity-efficacy tensions. Mixed-methods and longitudinal designs would further strengthen the field by linking teacher capability development with student outcomes and organizational routines, while also providing opportunities for further refinement of the CAE-8 framework.

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C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nvestigation

R : **R**esources

D : **D**ata Curation

O : Writing - **O**riginal Draft

E : Writing - Review & **E**ding

Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

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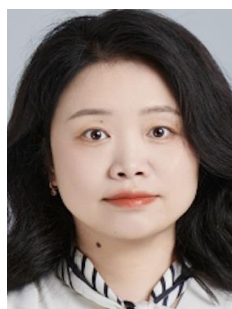
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