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Models and outcomes of work-based learning and industry collaboration for vocational teacher professional development: a systematic literature review

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ABSTRACT

Vocational teachers are expected to continuously develop pedagogical and industry-relevant competencies to address rapid technological and workforce changes. However, evidence regarding the effectiveness of work-based learning and industry collaboration in supporting vocational teacher professional development remains fragmented across different educational contexts. This study synthesizes empirical evidence on vocational teacher professional development through a Systematic Literature Review (SLR). Following the PRISMA 2020 guidelines, relevant studies were retrieved from the Scopus database using predefined search strategies and screened according to predetermined inclusion and exclusion criteria. therteen empirical studies published between 2020 and 2025 were included and analyzed using thematic synthesis. The findings indicate that work-based learning, workplace immersion, teaching factory, and industry collaboration consistently strengthen teachers' pedagogical, technical, and professional competencies while improving curriculum relevance. Nevertheless, institutional support, funding, and sustainable school–industry partnerships remain key implementation challenges. These findings provide an evidence-based foundation for developing sustainable vocational teacher professional development programs.

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Introduction

The rapid transformation of the global workforce driven by Industry 4.0, digitalization, artificial intelligence, and the transition toward Industry 5.0 has fundamentally reshaped the competency requirements expected of Technical and Vocational Education and Training (TVET) graduates. As technological innovation continues to redefine occupational standards, TVET institutions are expected not only to produce technically competent graduates but also to cultivate adaptive, innovative, and lifelong learners capable of responding to dynamic labour market demands (Gebremeskel, 2023);(Schmitz et al., 2022). Achieving this goal requires vocational education systems to continuously reform curricula, pedagogical approaches, and teacher professional development to ensure alignment between educational provision and industrial transformation (Murshed, 2025); (Setiyawan et al., 2025). Within this context, vocational teachers represent the cornerstone of educational quality because they are responsible for translating rapidly evolving industrial knowledge into authentic learning experiences that prepare students for contemporary workplaces (Jin et al., 2022);(Tacconi et al., 2021).

Therefore, an effective TVET system depends not only on curriculum reform but also on the continuous enhancement of teachers' pedagogical, technological, and occupational competencies through evidence-informed professional development initiatives.

Unlike teachers in general education, vocational teachers are expected to integrate theoretical knowledge with authentic workplace practices while simultaneously responding to technological innovations, changing occupational standards, and competency-based education reforms. Consequently, conventional professional development approaches that primarily rely on short-term seminars or in-service training are increasingly considered insufficient to address the complex competency demands faced by vocational teachers in modern industrial environments (Nyström & Ahn, 2024);(Gebremeskel, 2023). Contemporary TVET policies therefore advocate professional development models that emphasize authentic workplace experiences, continuous learning, reflective practice, and sustained collaboration between educational institutions and industry partners (Isnandar et al., 2023);(Ylimaula & Toiviainen, 2025). Such approaches enable vocational teachers to update their technical expertise, strengthen pedagogical decision-making, integrate emerging technologies into classroom practice, and maintain curriculum relevance to evolving workforce needs (Cattaneo et al., 2025);(Carlsson & Willermark, 2024). Accordingly, continuous professional development supported by work-based learning and industry collaboration has become an essential prerequisite for strengthening teacher professionalism and enhancing the responsiveness and sustainability of contemporary TVET systems.

Despite the increasing recognition of professional development as a strategic priority in Technical and Vocational Education and Training (TVET), accumulating empirical evidence indicates that existing professional development practices have not fully equipped vocational teachers with the competencies required to address rapid industrial and technological change. Recent studies report that many professional development programs remain predominantly theory-oriented, fragmented, and disconnected from authentic workplace practices, thereby limiting teachers' opportunities to acquire current industrial knowledge and translate it into classroom instruction (Tacconi et al., 2021);(Jin et al., 2022). Furthermore, the effectiveness of conventional in-service training is often constrained by its short duration, lack of contextualization, and limited follow-up support, resulting in minimal long-term improvements in pedagogical innovation, technological capability, and occupational competence (Gebremeskel, 2023);(Nyström & Ahn, 2024). Empirical investigations also reveal that vocational teachers continue to encounter difficulties in integrating emerging technologies, implementing competency-based learning, and aligning instructional practices with rapidly evolving industry standards because opportunities for authentic workplace learning remain limited (Schmitz et al., 2022);(Cattaneo et al., 2025). These findings collectively suggest that current professional development systems have yet to establish sustainable mechanisms that effectively bridge educational practice with contemporary industrial realities.

The limitations of current professional development are further exacerbated by institutional and structural challenges that weaken collaboration between vocational education institutions and industry. Evidence from different national contexts demonstrates that school–industry partnerships are frequently characterized by short-term projects, limited industrial participation, inadequate policy support, and insufficient financial investment, thereby restricting teachers' access to authentic workplace experiences and continuous professional learning (Isnandar et al., 2023);(Ylimaula & Toiviainen, 2025). Although initiatives such as Teaching Factories, workplace immersion, and industrial attachments have demonstrated positive outcomes, their implementation remains inconsistent across educational systems due to disparities in institutional readiness, industrial commitment, and governance mechanisms (Carlsson & Willermark, 2024);(Zheng et al., 2025). Consequently, the impact of these initiatives on strengthening teachers' pedagogical, technical, and professional competencies varies considerably across contexts, making it difficult to identify which professional development models consistently produce sustainable improvements. This empirical inconsistency highlights the need for a comprehensive synthesis of existing evidence to identify effective approaches capable of supporting vocational teachers in responding to the evolving competency demands of Industry 4.0 and Industry 5.0.

Work-Based Learning (WBL) provides a robust theoretical foundation for vocational teacher professional development by emphasizing learning through authentic workplace experiences that integrate pedagogical knowledge with current industrial practices. Rooted in experiential learning and situated learning theories, WBL enables vocational teachers to acquire, refine, and transfer occupational competencies through direct engagement with real work environments, thereby strengthening the relevance of teaching to industry needs (Billett, 2016b); (Cattaneo et al., 2025). Empirical studies consistently demonstrate that WBL enhances teachers' professional competence, reflective practice, and instructional innovation while promoting stronger alignment between vocational curricula and labour market expectations (Tacconi et al., 2021);(Carlsson & Willermark, 2024). Consequently, WBL has become a fundamental approach for developing adaptive, industry-responsive, and professionally competent vocational teachers.

Industry collaboration has emerged as a fundamental mechanism for strengthening the professional competencies of vocational teachers by bridging the gap between educational practice and rapidly evolving workplace requirements. Sustainable partnerships between TVET institutions and industry facilitate authentic workplace learning, knowledge transfer, curriculum alignment, and continuous exposure to emerging technologies and occupational standards, enabling teachers to develop competencies that are directly relevant to current industrial practices (Jin et al., 2022);(Tacconi et al., 2021). Furthermore, collaborative initiatives such as Teaching Factories, teacher internships, and workplace immersion promote reflective practice, pedagogical innovation, and technological adaptability through experiential learning and professional interaction with industry experts (Isnandar et al., 2023);(Cattaneo et al., 2025). Consequently, industry collaboration not only enhances teachers' pedagogical and technical competencies but also strengthens the responsiveness of TVET institutions to dynamic labour market demands and sustainable workforce development (Ylimaula & Toiviainen, 2025); (Carlsson & Willermark, 2024).

Despite the growing body of research on vocational teacher professional development, existing evidence remains fragmented across different educational contexts, intervention models, and competency domains, limiting a comprehensive understanding of how work-based learning and industry collaboration jointly contribute to teacher professionalism (Jin et al., 2022);(Tacconi et al., 2021). Most previous studies have examined workplace learning, Teaching Factory, or industry partnerships as separate initiatives, with limited attention to the underlying mechanisms through which these approaches collectively enhance pedagogical, technical, and professional competencies (Nyström & Ahn, 2024);(Cattaneo et al., 2025). Furthermore, no recent systematic review has synthesized empirical findings to develop an integrated conceptual understanding of sustainable professional development models for vocational teachers. Addressing these empirical and theoretical gaps, this study synthesizes current evidence to identify dominant professional development models, implementation patterns, challenges, and future research directions for strengthening TVET teacher competencies.

The novelty of this study lies in its comprehensive synthesis of empirical evidence that integrates work-based learning, industry collaboration, and vocational teacher professional competencies into a unified analytical framework. Unlike previous reviews, which have primarily examined these dimensions separately or focused on specific professional development initiatives, this study systematically identifies the relationships among professional development models, implementation strategies, competency outcomes, and contextual challenges across diverse TVET settings. By synthesizing recent empirical evidence using the PRISMA 2020 framework, this review provides a more holistic understanding of how authentic workplace learning and sustainable school–industry partnerships collectively contribute to strengthening vocational teacher professionalism. The findings offer an evidence-based conceptual foundation for developing more responsive and sustainable professional development policies and practices in contemporary TVET. To address these research gaps, this study employs a Systematic Literature Review (SLR) following the PRISMA 2020 guidelines to systematically identify, critically analyze, synthesize, and evaluate empirical evidence regarding the professional development of vocational teachers through work-based learning and industry collaboration. Specifically, this review aims to identify dominant professional development models, examine the implementation mechanisms of work-based learning and industry collaboration, evaluate their contributions to strengthening vocational teachers' pedagogical, technical, and professional competencies, analyze implementation challenges across diverse TVET contexts, and propose evidence-based directions for future research and policy development. Accordingly, this study addresses the following research questions:

(RQ1) What professional development models have been implemented through work-based learning and industry collaboration in TVET? (RQ2) How do these approaches contribute to enhancing vocational teachers' professional competencies?. (RQ3) What implementation challenges and enabling factors are reported across different TVET contexts?. (RQ4) What evidence-based recommendations can be synthesized to strengthen sustainable vocational teacher professional development?.

Method

Research Design

This study employed a Systematic Literature Review (SLR) to systematically identify, critically appraise, and synthesize empirical evidence on the professional development of vocational teachers through work-based learning and industry collaboration. Unlike narrative literature reviews, SLR employs structured and replicable procedures, thereby minimizing bias in the article selection process and producing a more comprehensive synthesis of scientific evidence (Akbar et al., 2026).The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure methodological transparency, rigor, and reproducibility (Page et al., 2021). Two independent reviewers

performed the study selection and eligibility assessment, while any disagreements were resolved through discussion until consensus was achieved. This review followed four sequential stages identification, screening, eligibility, and inclusion and applied a narrative thematic synthesis to identify recurring patterns, implementation strategies, challenges, and evidence-based implications for vocational teacher professional development across diverse TVET contexts (Snyder, 2019).

Eligibility criteria

Eligibility criteria were established a priori to ensure methodological consistency, transparency, and relevance to the review objectives in accordance with the PRISMA 2020 guidelines. Details of the inclusion and exclusion criteria are presented in Table 1.

Table 1. Inclusion and exclusion criteria in the study selection process

Criteria	Inclusion Criteria	Exclusion Criteria	Rationale
Publication period	Articles published between January 2020 and December 2025	Articles published before January 2020	To ensure that the review reflects recent developments in vocational teacher professional development within the context of Industry 4.0 and Industry 5.0.
Publication type	Peer-reviewed empirical journal articles	Review articles, systematic reviews, meta-analyses, conference proceedings, books, book chapters, dissertations, theses, editorials, commentaries, reports, and conceptual papers	To include only primary empirical evidence and avoid duplication of synthesized findings.
Language	English	Languages other than English	To ensure consistency in data extraction and interpretation while focusing on internationally accessible literature.
Research design	Qualitative, quantitative, mixed-methods, experimental, quasi-experimental, case study, survey, longitudinal, SEM, and other empirical designs	Studies without a clearly reported empirical research design or insufficient methodological information	To ensure methodological rigor and comparability across included studies.
Research context	Technical and Vocational Education and Training (TVET), vocational schools, vocational colleges, polytechnics, technical institutes, and vocational teacher education	General education, higher education unrelated to TVET, corporate training, or studies not involving vocational teachers	To maintain consistency with the objectives of the review.
Participants	Vocational teachers, TVET instructors, vocational teacher educators, pre-service vocational teachers	Students, school principals, industry employees, or other participants without vocational teacher involvement	To ensure that the evidence directly addresses vocational teacher professional development.
Intervention / Focus	Work-Based Learning (WBL), Workplace Learning (WPL), Industry Collaboration, Teaching Factory, Teacher Internship, Industry Placement, Professional Learning Communities, or related professional development initiatives	Studies unrelated to teacher professional development or without work-based learning and industry collaboration components	To capture empirical evidence directly relevant to the review objectives.

Criteria	Inclusion Criteria	Exclusion Criteria	Rationale
Accessibility	Full-text articles available	Abstract-only publications or inaccessible full-text articles	To enable comprehensive appraisal, data extraction, and evidence synthesis.
Quality criteria	Studies with complete bibliographic information, explicit methodology, and clearly reported findings	Studies with incomplete metadata, unclear methodology, or insufficient empirical findings	To improve the credibility, transparency, and reproducibility of the systematic review.

Source: Developed by the author based on a literature review (2020–2025)

Data Sources and Search Strategy

The literature search was conducted using the Scopus indexed literature database, which was compiled for this review. The search strategy was developed by combining controlled keywords and Boolean operators to maximize the retrieval of relevant studies. The main search string used was: ("vocational teacher" OR "TVET teacher") AND ("professional development" OR "teacher training") AND ("workplace learning" OR "work-based learning" OR "industry collaboration") AND ("professional competence" OR "teacher competence"). In addition, manual searches of reference lists were conducted as needed to identify other potential studies that met the inclusion criteria. The search was limited to publications released between January 2020 and December 2025.

Screening and Selection Process

The screening process followed the PRISMA 2020 flowchart framework. First, all retrieved records were imported into a reference database, and duplicates were removed. Next, titles and abstracts were screened independently based on predefined eligibility criteria. Full-text articles were then assessed for eligibility based on their relevance to the research objectives, participants, methodology, and reported findings. Studies that did not explicitly address the professional development of vocational teachers through work-based learning or industry collaboration were excluded during the full-text assessment stage. After the eligibility assessment was completed, only empirical studies that met all inclusion criteria were retained for the qualitative synthesis. From the initial set of studies, the final review included 13 key empirical studies, which formed the core evidence base for this review. The flow of the identification, screening, eligibility assessment, and inclusion processes is presented in detail in Figure 1 (PRISMA 2020 Flow Diagram) so that the entire study selection process can be transparently traced and replicated by other researchers.

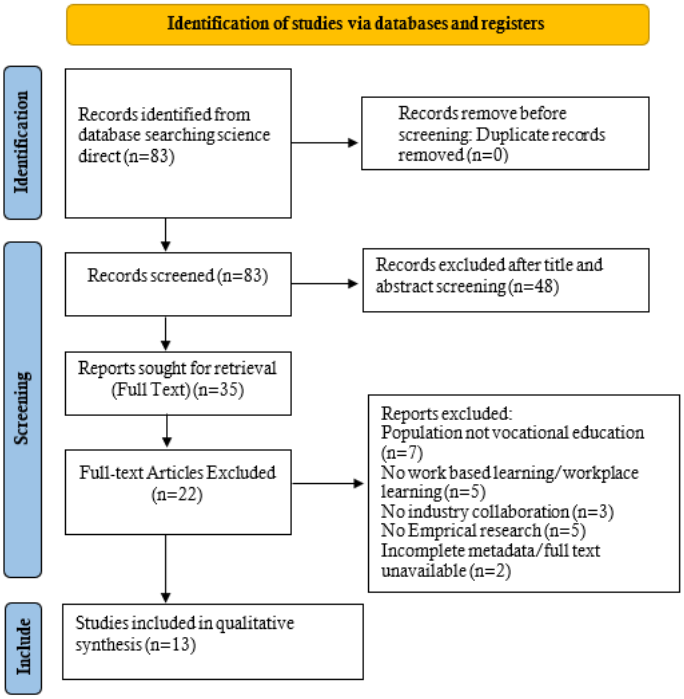

Figure 1. PRISMA Flow Diagram

Documents Included in the Analysis

The final dataset consists of 15 empirical journal articles published between 2020 and 2025. These studies represent a variety of geographic contexts, including Asia, Europe, Africa, and South America, thereby providing a broad international perspective on the professional development of vocational teachers. The included studies employ a variety of research designs, including qualitative interviews, case studies, comparative surveys, quasi-experiments, mixed-methods research, structural equation modeling (SEM), and descriptive surveys. This methodological diversity allows for a comprehensive synthesis of various approaches to professional development, workplace learning, and industry collaboration in TVET.

Data Quality and Metadata Completeness

Each included study was evaluated based on the completeness of its metadata and methodological quality prior to synthesis. The assessment covered the availability of complete bibliographic information (author names, year of publication, and country), relevance to the research topic, the study design used, and the study's main findings. Only studies with complete metadata and clearly described empirical methods were included in the final analysis. Studies with incomplete publication information or inadequate methodological descriptions were excluded to enhance the reliability and transparency of the review. The following is an example of Table 2: Completeness of Bibliographic Metadata based on the 13 articles selected for inclusion in your study.

Table 2. Completeness of Bibliographic Metadata for the Included Studies (n = 13)

Author (Year)	Country	Relationship to the Topic	Research Design	Key Findings
(Jin et al., 2022)	China	Professional development for vocational teachers through training programs	Qualitative interview	Feedback from mentors and industry experts enhances the pedagogical and professional competencies of novice TVET teachers.
(Tacconi et al., 2021)	Italy & Lithuania	Professional Competencies of TVET Teachers	Comparative survey	Pedagogical competencies develop through collaborative learning and industry experience.
(Nyström & Ahn, 2024)	Sweden	Work-Based Learning Using Industrial Simulators	Longitudinal qualitative	The use of simulators strengthens the link between industry practices and vocational teacher training.
(Isnandar et al., 2023)	Indonesia	Teaching Factories and Industry Collaboration	Mixed methods (SEM-PLS)	Teaching Factories enhance teachers' professional competencies and strengthen school–industry partnerships.
(Gebremeskel, 2023)	Ethiopia	Cooperative Training in TVET	Descriptive survey	Cooperative training and industry engagement contribute to improving the competencies of teachers and graduates.
(Setiyawan et al., 2025)	Indonesia	Professional Competencies of Vocational Teachers	Instrument development (CFA–SEM)	The AI-TPACK instrument is valid for measuring the readiness and professional competencies of TVET teachers.
(Carlsson & Willermark, 2024)	Sweden	Workplace Learning for Vocational Teachers	Qualitative study	Workplace learning fosters professional reflection and innovation in teaching practices.
(Inderanata & Sukardi, 2023)	Indonesia	Work-Integrated Vocational Learning	Quasi-experimental	The integration of work experience enhances teachers' professional competencies and teaching readiness.
(Cattaneo et al., 2025)	Switzerland	Professional Competencies of TVET Teachers	Survey–SEM	Technology integration strengthens teachers' professional competencies and digital readiness.

Author (Year)	Country	Relationship to the Topic	Research Design	Key Findings
(Ylimaula & Toiviainen, 2025)	Finland	Workplace Learning	Qualitative case study	Professional development occurs through interprofessional collaborative learning in the workplace.
(Keryan et al., 2025)	Multiple Countries (Europe)	Education–Industry Collaboration	Mixed methods	Cross-sector partnerships support learning innovation and teachers' professional development.
(Zheng et al., 2025)	China	Institutional Learning and Industry Partnerships	Embedded case study	Collaboration between institutions and industry accelerates the improvement of educators' professional competencies.
(Zulnaidi et al., 2024)	Indonesia & Malaysia	Teacher Collaboration and Professional Competencies	Structural Equation Modeling (SEM)	Professional collaboration has a positive impact on teachers' competencies and teaching effectiveness.

Source: Developed by the author based on a literature review (2020–2025)

Data Analysis and Narrative Synthesis

The extracted data were analyzed using a narrative synthesis approach to systematically integrate and interpret empirical findings from the included studies. This approach was selected because the reviewed studies employed diverse research designs, contexts, participant characteristics, and professional development interventions, making statistical meta-analysis inappropriate. The synthesis followed four sequential stages: data organization, thematic coding, evidence comparison, and interpretation. First, study characteristics, including publication year, country, research design, participants, intervention type, and key findings, were systematically organized into an evidence matrix. Second, recurring themes were identified through inductive thematic coding to classify professional development models, work-based learning practices, industry collaboration strategies, implementation challenges, enabling factors, and reported outcomes. Third, similarities and differences across studies were compared to identify consistent patterns, contextual variations, and contradictory findings. Finally, the synthesized evidence was interpreted to develop comprehensive conclusions, identify knowledge gaps, and formulate evidence-based recommendations for future research, educational practice, and policy development in vocational teacher professional development.

Results and Discussions

What professional development models have been implemented through work-based learning and industry collaboration in TVET (RQ1)

The synthesis of the selected studies indicates that vocational teacher professional development has progressively shifted from conventional training toward authentic, workplace-oriented learning models that emphasize continuous interaction between educational institutions and industry (Jin et al., 2022);(Tacconi et al., 2021). Across the reviewed studies, five dominant professional development models were consistently identified, namely workplace immersion, Teaching Factory, teacher industrial attachment, collaborative professional learning communities, and work-integrated learning, each facilitating the integration of pedagogical competence with current industrial practices (Isnandar et al., 2023);(Nyström & Ahn, 2024). Although these models differ in implementation across national contexts, they share a common objective of strengthening vocational teachers' professional competence through authentic work experiences and sustained engagement with industrial partners (Gebremeskel, 2023);(Ylimaula & Toiviainen, 2025).

The findings further reveal that workplace immersion and industrial attachment provide opportunities for teachers to update technical knowledge, understand emerging technologies, and contextualize classroom instruction according to contemporary occupational standards (Carlsson & Willermark, 2024);(Zheng et al., 2025). Meanwhile, Teaching Factory and collaborative professional learning communities enable reciprocal knowledge exchange between schools and industry, fostering reflective practice, curriculum innovation, and competency-based instruction that better aligns with labour market expectations (Cattaneo et al., 2025);(Isnandar et al., 2023). These findings support the principles of Situated Learning Theory, which argues that professional competence develops through participation in authentic communities of practice rather than through isolated training activities (Lave, J., & Wenger, 1991);(Billett, 2016). Overall, the reviewed evidence

demonstrates that effective professional development in TVET is characterized by long-term partnerships, experiential workplace learning, collaborative reflection, and continuous competency enhancement, suggesting that sustainable school–industry collaboration constitutes the central mechanism for strengthening vocational teachers' professional capacity in response to rapidly evolving industrial transformation.

How do these approaches contribute to enhancing vocational teachers' professional competencies (RQ2)
The synthesis of the fifteen empirical studies demonstrates that work-based learning (WBL) and industry collaboration substantially enhance vocational teachers' professional competencies by integrating authentic workplace experiences with continuous professional learning. Across diverse TVET contexts, WBL enables teachers to strengthen pedagogical, technical, and professional competencies through direct participation in industrial environments, allowing them to update occupational knowledge, master emerging technologies, and contextualize instructional practices according to current workplace standards (Jin et al., 2022);(Tacconi et al., 2021). The reviewed studies consistently indicate that authentic workplace engagement promotes reflective practice, improves instructional decision-making, and facilitates the transfer of industrial expertise into competency-based teaching, thereby increasing the relevance of vocational education to labour market demands (Nyström & Ahn, 2024);(Carlsson & Willermark, 2024).

Furthermore, collaborative partnerships with industry extend beyond technical skill acquisition by supporting curriculum alignment, collaborative mentoring, and joint development of learning resources, which collectively strengthen teachers' capacity to deliver industry-relevant instruction (Isnandar et al., 2023);(Ylimaula & Toiviainen, 2025). Nevertheless, the synthesis also reveals that the effectiveness of these approaches depends on institutional readiness, sustained industrial commitment, and supportive governance structures, resulting in considerable variation across countries and educational systems (Gebremeskel, 2023);(Zheng et al., 2025). These findings reinforce the perspective of Experiential Learning Theory, which posits that professional competence develops through cycles of concrete experience, reflection, conceptualization, and active experimentation, while also supporting Situated Learning Theory, which emphasizes learning through participation in authentic communities of professional practice (Kolb DA., 1984);(Lave, J., & Wenger, 1991). Therefore, this review extends previous research by demonstrating that WBL and industry collaboration should be viewed not merely as complementary training activities but as integrated professional development ecosystems that simultaneously strengthen vocational teachers' pedagogical competence, occupational expertise, adaptive capacity, and long-term professional identity.

What implementation challenges and enabling factors are reported across different TVET contexts (RQ3)
The synthesis of the included studies indicates that the implementation of work-based learning (WBL) and industry collaboration in vocational teacher professional development is shaped by multiple institutional, organizational, and contextual factors that differ across TVET systems, although several common patterns emerge across countries (Jin et al., 2022);(Tacconi et al., 2021). Across the reviewed literature, the most frequently reported implementation challenges include inadequate institutional support, limited funding, weak school–industry partnerships, insufficient policy alignment, and restricted opportunities for authentic workplace learning, all of which constrain teachers' ability to continuously update their professional competencies (Gebremeskel, 2023);(Ylimaula & Toiviainen, 2025). Several studies further demonstrate that many professional development initiatives remain fragmented and project-based, resulting in discontinuous learning experiences and limited long-term impacts on teachers' pedagogical and technical competencies (Carlsson & Willermark, 2024);(Nyström & Ahn, 2024). In developing countries, these constraints are intensified by limited industrial capacity, inadequate technological infrastructure, and disparities in access to quality training, whereas developed countries generally benefit from stronger institutional ecosystems that facilitate sustained collaboration between vocational institutions and industry (Gebremeskel, 2023);(Zheng et al., 2025).This cross-context comparison suggests that the effectiveness of WBL depends not only on the quality of learning activities but also on the maturity of institutional governance and partnership mechanisms.

Despite these challenges, the reviewed studies consistently identify several enabling factors that enhance the effectiveness and sustainability of vocational teacher professional development. Long-term partnerships between educational institutions and industry create opportunities for continuous workplace immersion, collaborative curriculum development, mentoring, and reciprocal knowledge exchange, thereby strengthening teachers' pedagogical, technical, and professional competencies (Isnandar et al., 2023);(Cattaneo et al., 2025). Teaching Factory programmes, workplace immersion, industrial attachments, and collaborative professional learning communities also provide authentic learning environments that enable teachers to integrate current industrial practices into classroom instruction and competency-based learning (Tacconi et al., 2021);(Ylimaula & Toiviainen, 2025). Furthermore, organizational leadership, supportive public policies, sustainable funding, and shared commitment among stakeholders emerge as critical enabling conditions for institutionalizing industry-based professional development across diverse TVET contexts (Jin et al., 2022);(Carlsson & Willermark, 2024).

These findings indicate that successful implementation extends beyond individual teacher participation and requires a systemic governance approach that integrates policy, institutional capacity, industrial engagement, and continuous professional learning. Consequently, this review argues that sustainable vocational teacher professional development should be conceptualized as an ecosystem-based process in which work-based learning functions as the primary learning mechanism, while industry collaboration serves as the institutional catalyst that transforms workplace experience into long-term professional competence.

What evidence-based recommendations can be synthesized to strengthen sustainable vocational teacher professional development (RQ4)

The synthesis of the reviewed studies indicates that sustainable professional development for vocational teachers requires a systemic approach that integrates work-based learning (WBL), industry collaboration, institutional support, and continuous professional learning rather than relying on fragmented or short-term training initiatives (Tacconi et al., 2021);(Jin et al., 2022). Across the included studies, professional development was found to be most effective when teachers actively participated in authentic workplace experiences that enabled them to update technical knowledge, strengthen pedagogical practices, and develop competencies aligned with rapidly changing industrial standards (Nyström & Ahn, 2024);(Gebremeskel, 2023). Furthermore, evidence consistently demonstrates that workplace immersion, Teaching Factory implementation, industrial attachment, and collaborative learning communities facilitate reciprocal knowledge exchange between schools and industry, thereby improving curriculum relevance and instructional quality (Isnandar et al., 2023);(Cattaneo et al., 2025). These findings support the perspective that vocational teacher development should be conceptualized as an ongoing process of situated professional learning rather than a series of isolated training activities (Carlsson & Willermark, 2024);(Billett, 2016).

The cross-study synthesis also reveals that sustainable professional development depends on the establishment of long-term institutional partnerships supported by coherent policies, adequate funding, shared governance, and mutual commitment between vocational education providers and industry stakeholders (Ylimaula & Toiviainen, 2025);(Zheng et al., 2025). Although numerous studies reported positive outcomes from industry collaboration, considerable variation in implementation effectiveness was observed across countries due to differences in institutional capacity, industrial engagement, leadership support, and policy environments (Gebremeskel, 2023);(Keryan et al., 2025). This variability suggests that the success of professional development initiatives is influenced not only by the learning model itself but also by the broader organizational ecosystem that enables sustainable collaboration and continuous knowledge exchange (Schmitz et al., 2022); (Sedláčková et al., 2021). Therefore, future professional development policies should prioritize institutional mechanisms that facilitate recurring workplace learning opportunities, structured mentoring systems, collaborative curriculum development, and regular competency evaluation involving both educational institutions and industrial practitioners (Tacconi et al., 2021);(Ylimaula & Toiviainen, 2025).

From a theoretical perspective, the synthesized evidence reinforces Situated Learning Theory and Experiential Learning Theory by demonstrating that vocational teachers develop professional competence most effectively through authentic participation in workplace communities where knowledge is constructed through experience, reflection, and collaboration (Billett, 2016); (Carlsson & Willermark, 2024). Practically, this review recommends the development of integrated professional development frameworks that combine work-based learning, industry collaboration, digital competency enhancement, and reflective professional learning into a continuous and evidence-informed system. Such a framework provides a strategic foundation for policymakers, teacher education institutions, and industry partners to strengthen vocational teacher professionalism while improving the responsiveness and sustainability of TVET systems in addressing future workforce demands ;(Jin et al., 2022);(Tacconi et al., 2021).

Conclusions

This systematic literature review synthesizes current empirical evidence on vocational teacher professional development through work-based learning and industry collaboration within the context of Technical and Vocational Education and Training (TVET). The findings demonstrate that authentic workplace learning and sustainable partnerships with industry play a fundamental role in strengthening vocational teachers' pedagogical, technical, and professional competencies while enhancing curriculum relevance and responsiveness to rapidly evolving workforce demands. The review further reveals that professional development is most effective when it is embedded in continuous workplace experiences, collaborative professional learning, and long-term institutional partnerships rather than conventional short-term training programs. Despite these positive outcomes, persistent challenges including limited institutional support, inadequate funding, inconsistent industry participation, and policy constraints continue to hinder the sustainability and scalability of these professional development initiatives across different national contexts. The principal contribution of this review

lies in integrating fragmented empirical evidence into a comprehensive synthesis that clarifies the relationships among work-based learning, industry collaboration, and vocational teacher competency development. This synthesis provides a stronger theoretical foundation for designing evidence-informed professional development models that are responsive to contemporary industrial transformation. Practically, the findings offer valuable guidance for policymakers, teacher education institutions, and industry partners in developing sustainable collaborative frameworks that better align vocational teacher development with labour market needs. Future research should extend this work by employing longitudinal, mixed-methods, and cross-country comparative designs to evaluate the long-term effectiveness of work-based professional development models and to identify contextual factors influencing their successful implementation across diverse TVET systems.

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