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Review Article

Mapping Research Trends, Themes, and Future Directions of Teaching Factory in Vocational Education: A Systematic Literature Review

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ABSTRACT

Purpose of the study: Despite the growing number of Teaching Factory studies, a comprehensive synthesis of its research development remains limited. Therefore, this study systematically reviews Teaching Factory research in vocational education published between 2017 and 2026 to identify publication trends, methodological characteristics, major research themes, research gaps, and future research directions.

Methodology: This study employed a Systematic Literature Review (SLR) following the PRISMA 2020 guidelines. Literature was retrieved exclusively from the Scopus database using predefined search terms related to Teaching Factory and vocational education. Of 64 identified records, 20 peer-reviewed journal articles meeting the inclusion criteria were analyzed using descriptive and thematic synthesis.

Main Findings: The findings revealed a fluctuating but increasing publication trend, with quantitative studies representing the dominant research approach. Six major research themes were identified: Teaching Factory implementation and evaluation, employability and work readiness, industry collaboration, entrepreneurship and industrial work culture, model development, and digital transformation. Several research gaps were also identified, particularly regarding empirical validation, longitudinal research, industry partnership evaluation, and Digital Teaching Factory development.

Novelty/Originality of this study: Unlike previous reviews that examined specific aspects of Teaching Factory, this study provides an integrated evidence-based synthesis of publication trends, methodological characteristics, thematic evolution, research gaps, and future research directions. It also proposes a future research agenda highlighting the shift from implementation-focused studies toward impact-oriented and digitally driven vocational education research.

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1. INTRODUCTION

Vocational education plays a strategic role in preparing a skilled workforce capable of meeting the rapidly evolving demands of industry [1]-[3]. As technological advancements and industrial transformation continue to reshape the world of work, vocational education institutions are expected not only to equip students with technical competencies but also with employability skills, problem-solving abilities, adaptability, and

professional work ethics [4], [5]. Nevertheless, a growing body of research indicates that vocational education systems still face persistent challenges related to the mismatch between graduates' competencies and industry requirements. This issue is reflected in the existence of qualification gaps and skills gaps, as well as the continuing need to strengthen the integration between education and industry [6]-[8]. These challenges have encouraged educational institutions and policymakers to develop learning models that can enhance the relevance of vocational education to labor market needs [9]-[11].

One approach that has been widely adopted to address these challenges is the Teaching Factory (TeFa) model [11]-[14]. Teaching Factory integrates learning activities with real production processes and industrial work culture, allowing students to gain authentic workplace experience while still studying in an educational setting [15], [16]. Through this approach, vocational institutions can bridge the gap between classroom learning and industrial practice while enhancing students' technical and professional competencies [17]-[19]. Consequently, Teaching Factory has become an important strategy for strengthening the link and match between vocational education and industry needs [20]-[23].

Numerous empirical studies have shown that the implementation of Teaching Factory has a positive impact on both the learning process and educational outcomes in vocational education [19], [24], [25], [26], [27]. Research findings indicate that Teaching Factory helps improve students' technical competencies, employability skills, work readiness, and entrepreneurial capabilities, while also strengthening collaboration between vocational education institutions and industry partners [28]-[31]. In addition, recent studies have highlighted the integration of Industry 4.0 technologies, digital manufacturing systems, and innovative learning approaches within Teaching Factory environments, further demonstrating the growing relevance of this model in addressing the demands of modern industry [32]-[34].

As the number of publications on Teaching Factory continues to grow, several review studies have been conducted from different perspectives. Handito et al., [35] examined the relationship between Teaching Factory and Computational Thinking through a bibliometric analysis, while Pratama et al., [12] reviewed the implementation of Teaching Factory in vocational education. Rifai et al., [36] mapped the Teaching Factory research landscape using a Systematic Literature Review approach combined with bibliometric analysis. Other review studies have focused on more specific aspects, including the development of a Green Campus-based Teaching Factory [37], the integration of quality management within Teaching Factory environments in the Industry 4.0 era [38], and the development of an Integrated Teaching Factory framework aimed at enhancing competencies aligned with industry standards [39].

Although these review studies have contributed to understanding specific dimensions of Teaching Factory, several important limitations remain. Existing reviews primarily focus on particular aspects, such as Computational Thinking integration, implementation practices, quality management, sustainability, conceptual model development, or bibliometric mapping [35]-[39]. Consequently, they provide only a partial understanding of the development of Teaching Factory research. To date, no review has comprehensively synthesized publication trends, methodological characteristics, dominant research themes, research gaps, and future research directions within a single integrated review.

To address this gap, a comprehensive synthesis is needed to provide a clearer understanding of the development of Teaching Factory research and to identify priorities for future studies. Therefore, the present study conducts a comprehensive Systematic Literature Review (SLR) of Teaching Factory research in vocational education published between 2017 and 2026. Unlike previous review studies that have focused on specific dimensions of Teaching Factory, this review provides an integrated synthesis of publication trends, methodological characteristics, emerging research themes, and future research opportunities. By doing so, the study offers a broader understanding of the development of Teaching Factory research while identifying areas that warrant further investigation.

Therefore, this study aims to systematically review the development of Teaching Factory research in vocational education by analyzing publication trends, methodological characteristics, major research themes, research gaps, and future research directions. Specifically, this study seeks to answer the following research questions: (1) How have publication trends in Teaching Factory research evolved during the 2017–2026 period? (2) What methodological approaches have been most frequently employed in Teaching Factory research? (3) What are the major themes emerging from the Teaching Factory literature? and (4) What research gaps and future research directions can be identified from the existing literature? The findings of this study are expected to contribute to the advancement of Teaching Factory scholarship and provide valuable insights for researchers, practitioners, and policymakers involved in the development of vocational education.

2. RESEARCH METHOD

This study employed a Systematic Literature Review (SLR) approach to comprehensively synthesize research on Teaching Factory (TEFA) in vocational education. The SLR approach was selected because it enables the identification, selection, evaluation, and synthesis of relevant studies to be conducted in a systematic,

transparent, and replicable manner, thereby enhancing methodological rigor and the credibility of the review findings. To ensure consistency and transparency throughout the review process, this study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework developed by [40]. The PRISMA framework consists of four main stages: identification, screening, eligibility assessment, and study inclusion. Applying the PRISMA framework provided a structured procedure for selecting relevant literature while minimizing potential bias throughout the review process.

The literature search was conducted on June 7, 2026, using the Scopus database as the sole source of literature. Scopus was selected because it is one of the largest and most comprehensive bibliographic databases, indexing high-quality international journals across a wide range of disciplines, including vocational education and Technical and Vocational Education and Training (TVET). This review focused on studies published between 2017 and 2026 to capture the development of Teaching Factory research in vocational education over the past decade. The search strategy was designed to include a range of terms related to Teaching Factory and vocational education. The following search string was applied in Scopus: TITLE-ABS-KEY ("teaching factory" OR "tefa") AND TITLE-ABS-KEY (vocational OR TVET OR "vocational education" OR SMK)

The initial search yielded 64 documents. After applying filters for publication year (2017–2026) and language (English), the number of records was reduced to 61 articles. A subsequent title and abstract screening resulted in 26 articles being selected for full-text assessment. Following the eligibility evaluation, six articles were excluded because they did not meet the inclusion criteria, leaving 20 studies to be included in the final synthesis.

To ensure the relevance and quality of the studies included in this review, predefined inclusion and exclusion criteria were applied. The inclusion criteria were as follows: (1) peer-reviewed journal articles; (2) studies published between 2017 and 2026; (3) research focusing on Teaching Factory within the context of vocational education; (4) articles written in English; and (5) studies available in full-text format. Conversely, studies were excluded if they were conference proceedings, book chapters, review articles, editorials, published before 2017, unrelated to Teaching Factory in vocational education, or unavailable in full-text form.

Table 1. Inclusion and Exclusion Criteria

Category	Inclusion Criteria	Exclusion Criteria
Publication Type	Peer-reviewed journal articles	Conference proceedings, book chapters, review articles, and editorials
Publication Year	2017–2026	Before 2017
Topic	Teaching Factory (TEFA) in vocational education (Vocational Education, TVET, or Vocational High School/SMK)	Topics unrelated to Teaching Factory or vocational education
Language	Articles published in English	Non-English articles
Educational Context	Vocational education, TVET, vocational high schools (SMK), or vocational training	Non-educational or non-vocational contexts
Document Availability	Full-text articles available and accessible	Articles unavailable in full-text format
Research Focus	Teaching Factory implementation, models, research trends, outcomes, challenges, success factors, industry collaboration, or Teaching Factory development	Studies focusing solely on specific technologies, products, or systems without an explicit focus on Teaching Factory

The study selection process followed the PRISMA 2020 guidelines. The initial search identified 64 records from the Scopus database. After applying restrictions based on publication year (2017–2026) and language (English), three records were excluded, leaving 61 articles for the screening process. During the title and abstract screening stage, 35 articles were excluded because they did not align with the focus of the study, did not address Teaching Factory within the context of vocational education, or failed to meet the objectives of the review. As a result, 26 articles were retained for full-text assessment.

Following the eligibility assessment, six articles were excluded because they did not meet the inclusion criteria or showed limited relevance to the research questions. Consequently, a total of 20 studies were included in the final synthesis. A summary of the identification, screening, and study selection process is presented in Figure 1.

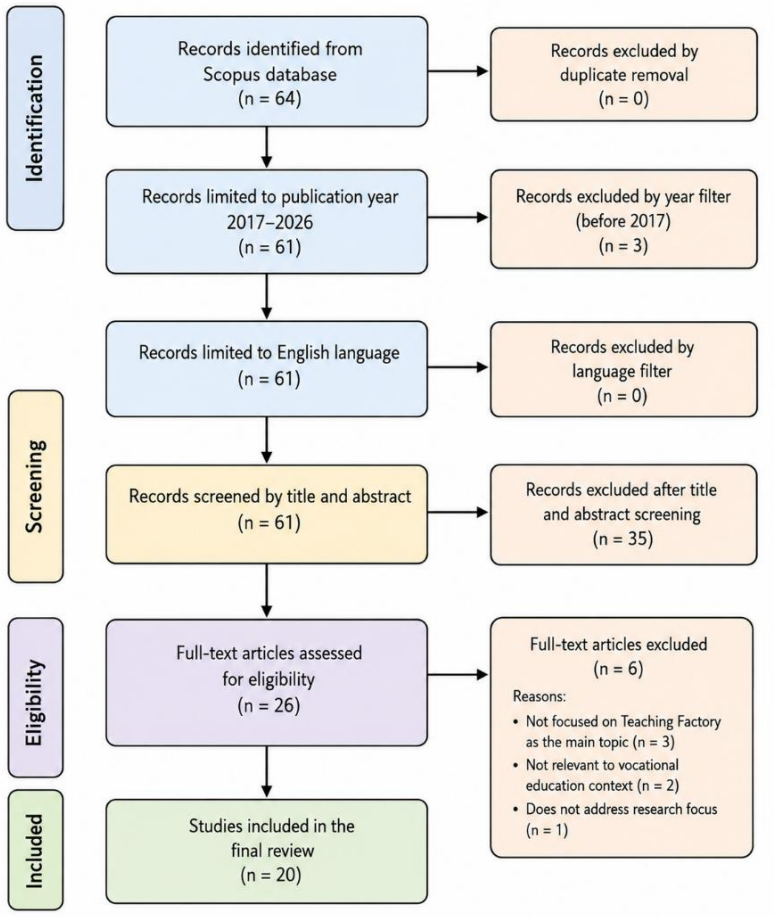

Figure 1. PRISMA 2020 Flow Diagram

A total of 20 selected studies were analyzed using descriptive analysis and thematic synthesis. Data were extracted systematically using a predefined data extraction form. The information collected included publication year, research methodology, research focus, main findings, and research gaps identified in each study. The analysis was conducted based on the four research questions formulated in this review. First, descriptive synthesis was used to identify publication trends in Teaching Factory research during the 2017–2026 period (RQ1). Second, descriptive synthesis was employed to examine the methodological characteristics of studies on Teaching Factory (RQ2). Third, thematic synthesis was used to identify and interpret the major themes emerging from the Teaching Factory literature (RQ3). Finally, thematic analysis was conducted to synthesize research gaps and formulate future research directions in the field of Teaching Factory (RQ4). To enhance the reliability of the review findings, all studies included in the analysis were systematically examined using the same coding framework and thematic categories. This approach ensured consistency in the data extraction and interpretation processes while reducing the potential for researcher bias during the synthesis process.

3. RESULTS AND DISCUSSION

3.1 Publication Trends in Teaching Factory Research in Vocational Education

The publication trend of Teaching Factory (TEFA) research in vocational education during the 2017–2025 period will illustrates in figure 2.

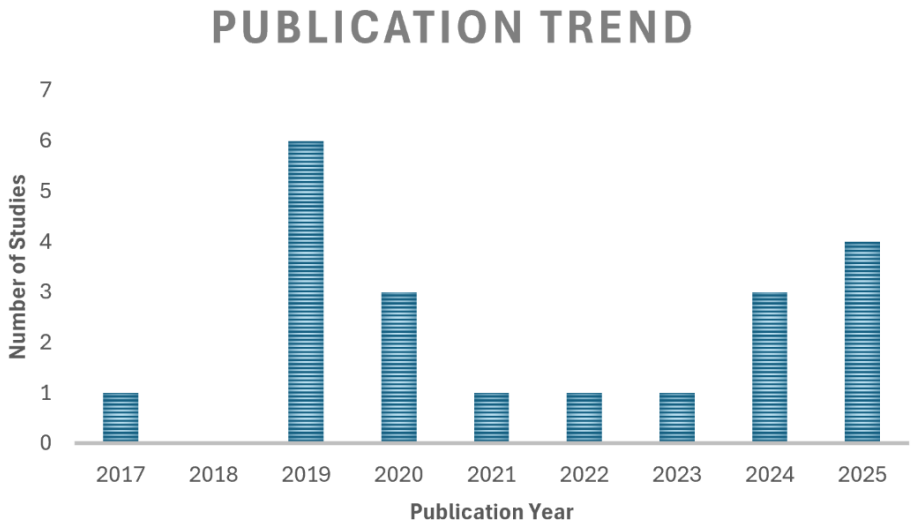

Figure 2. Publication Trend

Figure 2 illustrates the publication trend of Teaching Factory (TEFA) research in vocational education during the 2017–2025 period. Overall, the number of publications exhibited a fluctuating pattern but showed an upward trend toward the end of the review period. The earliest study identified in this review was published in 2017, with only one article meeting the inclusion criteria. No eligible articles were identified in 2018. The number of publications then increased substantially in 2019, reaching six articles (30%), the highest number recorded during the review period. In 2020, the number declined to three articles (15%) and remained relatively stable between 2021 and 2023, with one article (5%) published each year. Publication activity increased again in 2024, with three articles (15%), and reached four articles (20%) in 2025.

Based on this pattern, the development of Teaching Factory research can be divided into three major phases. The first phase, referred to as the introduction and early development phase (2017–2020), was characterized by growing scholarly interest in Teaching Factory as a production-based learning model in vocational education. During this period, most studies focused on model development, implementation evaluation, and the identification of factors supporting the successful implementation of Teaching Factory in vocational schools. The sharp increase in publications in 2019 reflects the growing attention given to Teaching Factory, driven by vocational education revitalization initiatives and efforts to strengthen the link and match between education and industry [41], [42]. In addition, Teaching Factory was increasingly recognized as a learning model capable of bridging the gap between graduates' competencies and industry needs [15].

The second phase, referred to as the research slowdown phase (2021–2023), was characterized by a relatively low and stable number of publications. This trend may be associated with the impact of the COVID-19 pandemic, which affected the implementation of practical training, laboratory activities, and collaboration with industry partners across many vocational education institutions [43], [44]. In addition, research attention during this period appears to have shifted toward issues related to online learning, digital transformation in education, and the adaptation of educational systems during the pandemic [45], [46]. As a result, research on Teaching Factory progressed at a slower pace compared to the previous phase.

The third phase, referred to as the revival and diversification phase (2024–2025), was marked by a renewed increase in publication output alongside a broader range of research topics. While earlier studies primarily focused on implementation and model development, recent research has increasingly examined the impact of Teaching Factory on employability skills, graduate work readiness, industrial work culture, partnerships with industry stakeholders, and the integration of digital technologies in vocational education. This shift suggests that Teaching Factory research is gradually moving beyond implementation-related issues toward the evaluation of educational outcomes and their relevance to labor market needs and the challenges of Industry 4.0.

3.2 Research Methods Used in Teaching Factory Studies

The characteristics of the research methods employed in Teaching Factory (TEFA) studies are presented in Table 2. The analysis revealed that quantitative research was the most frequently used approach, accounting for six articles (30%). Qualitative research was identified in five articles (25%), followed by mixed-methods studies in four articles (20%). In addition, three articles (15%) employed literature review or conceptual

approaches, while one article (5%) used a Research and Development (R&D) methodology and another one article (5%) adopted a program evaluation approach.

Table 2. Characteristics of Research Methods in Teaching Factory Studies

Category	Subcategory	n	%
Research Method	Qualitative	5	25
	Quantitative	6	30
	Mixed Methods	4	20
	Research and Development (R&D)	1	5
	Literature Review / Conceptual Study	3	15
	Program Evaluation	1	5
Total		20	100

The predominance of quantitative research suggests that Teaching Factory scholarship is increasingly moving toward the empirical assessment of program outcomes. The quantitative studies identified in this review primarily focused on measuring employability skills, work readiness, program effectiveness, and factors influencing the successful implementation of Teaching Factory. The use of diverse analytical techniques, including surveys, SEM-PLS, multivariate analysis, and pre-test–post-test designs, reflects ongoing efforts to generate stronger empirical evidence regarding the effectiveness of Teaching Factory in vocational education.

Nevertheless, qualitative research still accounted for a substantial proportion of the reviewed studies. Most qualitative investigations focused on exploring Teaching Factory implementation, institutional readiness, management systems, enabling and constraining factors, as well as the dynamics of school–industry relationships. The prominence of qualitative approaches during the early stages of Teaching Factory research suggests that researchers were primarily concerned with understanding the implementation context before undertaking broader evaluations of program outcomes.

Another notable finding is the increasing use of mixed-methods approaches. This approach enables researchers to combine the strengths of quantitative and qualitative data, providing a more comprehensive understanding of Teaching Factory. Several mixed-methods studies not only evaluated program effectiveness but also developed models, validated instruments, and identified factors influencing successful implementation. This trend suggests that Teaching Factory research is evolving toward more integrative and multidimensional approaches.

In contrast, studies employing Research and Development (R&D) and program evaluation methodologies remain relatively limited in number. Yet, both approaches play an important role in developing innovative Teaching Factory models and systematically assessing their effectiveness. Likewise, the presence of literature reviews and conceptual studies indicates that the development of Teaching Factory conceptual frameworks continues to be an area of interest among researchers seeking to strengthen the theoretical foundations of vocational education.

3.3 Major Themes of Teaching Factory Research in Vocational Education

The thematic synthesis of the 20 studies included in this review identified six major themes within the Teaching Factory (TEFA) literature: (1) Teaching Factory implementation, readiness, and evaluation; (2) employability and work readiness; (3) industry collaboration and partnerships; (4) entrepreneurship and industrial work culture; (5) Teaching Factory model development and innovation; and (6) digital transformation and Education 4.0. A summary of the thematic synthesis is presented in Table 3.

Table 3. Thematic Synthesis of Teaching Factory Research in Vocational Education

Major Theme	Research Focus	Supporting Studies
Teaching Factory Implementation, Readiness, and Evaluation	Institutional readiness, program implementation, management systems, enabling and constraining factors, and evaluation of Teaching Factory implementation	[21], [47], [48], [49], [50]
Employability and Work Readiness	Employability skills, occupational competencies, soft skills, readiness for employment, and 21st-century skills	[19], [22], [51]

Major Theme	Research Focus	Supporting Studies
Industry Collaboration and Partnerships	Industry involvement, school–industry partnerships, curriculum alignment, and production-based learning	[11], [13], [52]
Entrepreneurship and Industrial Work Culture	Entrepreneurial mindset, industrial work culture, professionalism, work-related character development, and business orientation	[50], [53], [54], [55]
Teaching Factory Model Development and Innovation	Model development, model validation, instructional innovation, evaluation systems, and Teaching Factory management development	[13], [14], [17], [25], [56], [57], [58]
Digital Transformation and Education 4.0	Integration of digital technologies, Industry 4.0, ICT, Artificial Intelligence, and digital entrepreneurship within Teaching Factory environments	[54], [58]

Teaching Factory implementation, readiness, and evaluation emerged as the most prominent theme in the reviewed literature. Studies by [47]-[50] indicate that scholarly attention has largely focused on how Teaching Factory can be effectively implemented within vocational education. These studies emphasize the importance of human resource readiness, management support, infrastructure, management systems, and other factors that contribute to successful program implementation.

The findings suggest that Teaching Factory extends beyond a production-based learning model and should instead be viewed as a comprehensive system that integrates educational processes, management practices, and industrial work environments. This perspective highlights the complexity of implementing Teaching Factory and the need for strong institutional capacity to support its operation. Consequently, the success of Teaching Factory implementation largely depends on the readiness of institutions to develop a learning ecosystem that effectively integrates both production activities and educational objectives.

The theme of employability and work readiness reflects a shift in research focus from program implementation toward the evaluation of its impact on learners. Studies by [19], [22], [51] reported that Teaching Factory contributes positively to the development of occupational competencies, employability skills, communication abilities, teamwork, problem-solving skills, and readiness for employment. These findings suggest that Teaching Factory can effectively bridge the gap between school-based learning and workplace demands.

By providing learning experiences that closely resemble real industrial environments, Teaching Factory offers students opportunities to develop competencies that are aligned with the requirements of the modern labor market. The prominence of employability-related studies also reflects a growing interest in educational outcomes and graduate success following participation in Teaching Factory programs. This shift indicates that researchers are increasingly concerned not only with how Teaching Factory is implemented but also with how it contributes to learners' preparedness for employment and long-term career development. Industry collaboration and partnerships emerged as one of the most critical factors influencing the success of Teaching Factory. Studies by [11], [13], [52] demonstrate that industry involvement facilitates curriculum alignment, technology transfer, enhanced competency relevance, and the provision of authentic workplace experiences for students. These contributions help strengthen the connection between vocational education and the evolving needs of industry.

Interestingly, this theme emerged not only as a success factor but also as one of the major challenges in the implementation of Teaching Factory. Several studies indicate that establishing and sustaining long-term partnerships remains a significant challenge for many vocational education institutions. These findings suggest that the quality of school–industry relationships represents a strategic element that influences both the effectiveness of Teaching Factory and the long-term sustainability of the program. Therefore, fostering strong and mutually beneficial partnerships with industry is essential for maximizing the potential of Teaching Factory as a bridge between education and employment.

Beyond preparing students for employment, Teaching Factory also contributes to the development of entrepreneurship and industrial work culture. Studies by [53]-[55] indicate that students' involvement in market-oriented production and service activities fosters entrepreneurial mindsets, responsibility, discipline, professionalism, and a strong orientation toward quality standards. These experiences expose students to workplace expectations while encouraging the development of attitudes and behaviors valued in both industry and business settings.

The findings suggest that Teaching Factory serves not only as a platform for developing technical competencies but also as a means of cultivating work-related values and professional character aligned with the needs of industry. In this regard, Teaching Factory plays a strategic role in preparing graduates who are not only ready for employment but also possess the entrepreneurial capacity to create their own business opportunities and adapt to a rapidly changing labor market.

The theme of Teaching Factory model development and innovation suggests that much of the existing research remains focused on strengthening conceptual foundations and refining implementation models. Studies by [56]-[58] have concentrated on the development of models, evaluation systems, assessment instruments, and conceptual frameworks aimed at enhancing the effectiveness of Teaching Factory implementation. The prominence of this theme indicates that researchers are still seeking to identify Teaching Factory models that best align with the needs of vocational education and the evolving demands of industry. At the same time, it suggests that evidence regarding the long-term effectiveness of Teaching Factory remains relatively limited compared to the substantial body of research devoted to model development and conceptual validation. This imbalance highlights the need for future studies to move beyond model refinement and place greater emphasis on evaluating the long-term outcomes and sustainability of Teaching Factory initiatives in diverse vocational education contexts.

Although still relatively limited in scope, the theme of digital transformation and Education 4.0 represents an emerging direction in Teaching Factory research. Studies by [54], [58] have begun to integrate concepts such as Industry 4.0, digital technologies, information and communication technology (ICT), digital entrepreneurship, and artificial intelligence into vocational learning environments. The emergence of this theme suggests that Teaching Factory is gradually evolving from a conventional production-based model toward a more digital, adaptive, and technology-driven learning ecosystem. This development reflects the growing need for vocational education to respond to rapid technological advances and changing industry requirements. Consequently, digital transformation is likely to become one of the key areas of future Teaching Factory research, particularly in relation to preparing learners with the competencies required in technology-intensive industries. The integration of emerging technologies into Teaching Factory environments may also open new opportunities for innovation in teaching, learning, and industry collaboration.

Overall, the thematic synthesis indicates that Teaching Factory research in vocational education has evolved considerably over time. In its early stages, the literature was largely dominated by studies focusing on implementation, institutional readiness, and the development of Teaching Factory models [21], [25], [47]. Over time, research attention shifted toward evaluating the impact of Teaching Factory on employability skills, work readiness, and the development of industrial work culture [22], [51], [53].

At the same time, industry partnerships emerged as a central factor influencing the success of Teaching Factory implementation, while also representing one of the most frequently reported challenges faced by vocational education institutions [13], [52]. Furthermore, the emergence of digital transformation and Education 4.0 as research themes signals a new direction in the evolution of Teaching Factory, one that is increasingly responsive to technological change and future industry demands [54], [58]. Taken together, these findings suggest that Teaching Factory research has progressed beyond issues of model development and implementation toward a broader effort to understand its impact, sustainability, and relevance in addressing the challenges of workforce transformation in the twenty-first century.

3.4 Research Gaps and Future Directions in Teaching Factory Research

The synthesis of the reviewed studies revealed several research gaps that continue to limit the advancement of Teaching Factory scholarship. Identifying these gaps is essential for understanding the current state of knowledge and for guiding future research efforts. Table 4 summarizes the major research gaps identified in the literature, along with corresponding directions for future research.

Table 4. Research Gaps and Future Directions in Teaching Factory Research

Research Gap	Evidence from the Literature	Supporting Studies	Future Research Directions
Limited empirical validation of Teaching Factory models	Many studies continue to focus on model development and conceptual validation, with relatively few examining large-scale implementation in real vocational education settings.	[13], [17], [25], [57]	Examine the effectiveness of Teaching Factory models across different schools, vocational disciplines, and educational contexts.
Research concentrated in limited contexts	Most studies have been conducted within a single school, region, or vocational program, limiting the generalizability of findings.	[21], [48], [50], [51]	Conduct comparative studies across schools, regions, and vocational programs to enhance the external validity of findings.

Research Gap	Evidence from the Literature	Supporting Studies	Future Research Directions
Limited longitudinal research	The impact of Teaching Factory is typically assessed in the short term, with few studies tracking outcomes after graduates enter the workforce.	[19], [22], [49], [56]	Investigate the long-term effects of Teaching Factory on career development, employability, and graduate performance through longitudinal studies.
Limited comprehensive assessment of educational outcomes	Much of the existing literature focuses on implementation and model development rather than systematically evaluating learning outcomes and student competencies.	[13], [47], [48], [52]	Examine the effects of Teaching Factory on learning outcomes, competencies, employability skills, and work readiness using more rigorous quantitative approaches.
Insufficient investigation of industry engagement	Industry involvement is frequently identified as a critical factor, yet the quality, intensity, and effectiveness of partnerships remain underexplored.	[11], [22], [55], [57]	Develop partnership models and evaluation indicators to identify the most effective forms of school–industry collaboration.
Methodological limitations	Existing studies are still dominated by descriptive research, case studies, and model development approaches.	[17], [25], [53]	Employ mixed-methods, quasi-experimental, and longitudinal designs to generate stronger empirical evidence.
Digital Teaching Factory remains at an early stage of development	The integration of Artificial Intelligence, Industry 4.0, and digital technologies in Teaching Factory is still largely limited to conceptual development and preliminary validation.	[54], [58]	Develop and evaluate AI-driven Digital Teaching Factory models incorporating the Internet of Things, smart manufacturing, and digital entrepreneurship.

Based on the synthesis presented in Table 4, one of the major gaps in Teaching Factory research is the limited empirical validation of existing models. Studies by [13], [17], [25], [57] have primarily focused on model development, conceptual validation, and the design of Teaching Factory implementation frameworks. These findings suggest that the effectiveness of Teaching Factory models across diverse vocational education settings remains insufficiently examined. Therefore, future research should place greater emphasis on evaluating the implementation and effectiveness of Teaching Factory models across different schools, vocational disciplines, and educational contexts.

Another important gap relates to the limited scope of research contexts. Studies conducted by [21], [48], [50], [51] were generally confined to specific schools or vocational programs. As a result, the generalizability of their findings to broader vocational education contexts remains limited. To address this issue, comparative studies across schools, regions, and vocational disciplines are needed to provide a more comprehensive understanding of how Teaching Factory is implemented and adapted across different educational settings.

The synthesis also revealed a notable lack of longitudinal research. Studies by [19], [22], [49], [56] have primarily examined the effects of Teaching Factory during the learning process or over relatively short periods. However, one of the primary objectives of Teaching Factory is to enhance graduates' work readiness and success in the labor market. Therefore, longitudinal studies that track graduates after they enter the workforce represent an important research agenda for understanding the long-term impact of Teaching Factory on employability, career development, and professional success.

Another gap concerns the limited assessment of educational outcomes. Studies by [13], [47], [48], [52] have focused primarily on program implementation and model development rather than systematically evaluating their impact on learning outcomes, student competencies, employability skills, and work readiness. These findings highlight the need for more rigorous quantitative research to examine the contribution of Teaching Factory to a broader range of vocational education outcomes. Such evidence would provide a stronger basis for assessing the effectiveness of Teaching Factory and informing educational policy and practice.

With regard to industry partnerships, studies by [11], [22], [55], [57] consistently emphasize the importance of industry involvement in the success of Teaching Factory initiatives. However, research examining the quality, intensity, and effectiveness of such partnerships remains limited. Most studies treat industry as a

supporting stakeholder without systematically evaluating which forms of collaboration are most effective in achieving educational and workforce-related outcomes. Consequently, future research should focus on developing comprehensive models and evaluation indicators for school–industry partnerships to better understand and measure effective collaboration practices.

From a methodological perspective, Teaching Factory research continues to be dominated by descriptive studies, case studies, and model development approaches, as reflected in the works of [17], [25], [53]. While these studies have made important contributions to the conceptual development of Teaching Factory, the empirical evidence generated remains relatively limited. Therefore, stronger research designs, including mixed-methods, quasi-experimental, and longitudinal approaches, are needed to produce more robust and generalizable findings. Such methodological advancements would strengthen the evidence base for Teaching Factory and support more informed decision-making in vocational education policy and practice.

In addition, advances in digital technologies have created new opportunities for the development of Teaching Factory. Studies by [54], [58] indicate that the integration of digital technologies, Artificial Intelligence, and Industry 4.0 concepts into Teaching Factory remains at an early stage of development and conceptual validation. These findings suggest that Digital Teaching Factory is still an emerging area of research with considerable potential for further exploration through the development and evaluation of AI-driven models, the Internet of Things, smart manufacturing systems, and digital entrepreneurship initiatives.

Overall, the synthesis highlights several persistent gaps in Teaching Factory research, including limited empirical validation of existing models, restricted research contexts, the scarcity of longitudinal studies, the lack of comprehensive assessments of educational outcomes, insufficient evaluation of industry partnerships, the predominance of descriptive research designs, and the early-stage development of Digital Teaching Factory. These findings extend previous review studies by providing an integrated synthesis of publication trends, methodological characteristics, major research themes, and future research directions within a single review. Practically, the findings may assist researchers in identifying priority areas for future investigation and support educators, institutional leaders, and policymakers in strengthening Teaching Factory implementation and industry collaboration. Nevertheless, this review is limited to studies indexed in the Scopus database and published in English between 2017 and 2026. Future reviews are encouraged to incorporate additional databases and broader sources of evidence to provide a more comprehensive understanding of Teaching Factory research.

4. CONCLUSION

This study systematically reviewed the development of Teaching Factory research in vocational education to provide a comprehensive understanding of its publication trends, methodological characteristics, major research themes, research gaps, and future research directions. The findings indicate that Teaching Factory research has evolved from an initial focus on implementation and model development toward evaluating its impact on employability skills, work readiness, industrial work culture, and its relevance to labor market needs. Although the number of publications remains relatively limited, the increasing volume of research in recent years indicates that Teaching Factory continues to be recognized as an important approach for strengthening industry-oriented vocational education. The analysis of 20 studies identified six major themes that dominate the literature: Teaching Factory implementation, readiness, and evaluation; employability and work readiness; industry collaboration and partnerships; entrepreneurship and industrial work culture; Teaching Factory model development and innovation; and digital transformation and Education 4.0. These findings indicate that Teaching Factory research is no longer confined to implementation-related issues but is increasingly directed toward assessing educational outcomes and adapting vocational education to the demands of emerging industrial technologies. However, several research gaps remain. These include the limited empirical validation of Teaching Factory models, the scarcity of longitudinal studies, restricted research contexts, the lack of comprehensive assessments of educational outcomes, and the limited attention given to the effectiveness of industry partnerships and the development of Digital Teaching Factory. Accordingly, future research should strengthen empirical research designs, expand the scope of investigation, develop evaluation models for school–industry partnerships, and explore the integration of digital technologies such as Artificial Intelligence, the Internet of Things, and smart manufacturing within Teaching Factory environments.

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AUTHOR CONTRIBUTIONS

All authors have read and agreed to the published version of the manuscript. Conceptualization, Sefthy P. B. Syahailatua and Widihastuti; Methodology, Sefthy P. B. Syahailatua and Widihastuti; Data curation, Sefthy P. B. Syahailatua; Formal analysis, Sefthy P. B. Syahailatua and Widihastuti; Investigation, Sefthy P. B. Syahailatua; Writing – original draft preparation, Sefthy P. B. Syahailatua; Writing – review and editing, Widihastuti; Supervision, Widihastuti.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

INFORMED CONSENT STATEMENT

All images in this article have been authorized and are the property of the authors.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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