

Self-Efficacy and Teaching Practice in Engineering and Technical Education: A Systematic Literature Review

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Abstract—Teachers in engineering and technical education must be confident in their ability to use effective teaching methods in addition to having strong technical competencies. Research on the connection between self-efficacy and engineering and technical education teaching practices is thoroughly reviewed in this paper. Relevant empirical research was found, screened, and synthesized using the PRISMA framework in order to investigate the main facets of self-efficacy, the ways in which self-efficacy influences teaching practice, and the contextual elements that foster its growth. The results show that instructional planning, practical teaching, classroom and laboratory management, technological integration, instructional innovation, and professional involvement are all positively correlated with self-efficacy. In learning contexts with a lot of technology, technological self-efficacy has become especially crucial. Additionally, the review identifies outcome anticipation, subject-matter self-efficacy, instructional self-efficacy, and personal teaching efficacy as significant factors supporting teaching performance. Teachers' self-efficacy is also influenced by mastery experiences, professional growth, institutional support, teamwork, and exposure to professional practice. These results emphasize how crucial it is for professional development programs for educators in engineering and technical education to incorporate pedagogical, technical, and technological self-efficacy development.

Keywords—engineering education, technical education, teacher self-efficacy, teaching practice, professional development, technology integration.

I. INTRODUCTION

Engineering and technical education prepares learners to apply scientific principles, develop practical competencies, and respond to the demands of evolving technologies. In this educational context, teaching involves more than explaining theoretical concepts. Educators are also expected to demonstrate technical procedures, facilitate practical learning activities, manage workshops and laboratories, and select instructional approaches that connect theoretical knowledge with professional practice. Consequently, the quality of technical education is shaped not only by curriculum design and the availability of learning facilities but also by educators' competencies and their confidence in performing instructional tasks (Watrianthos et al., 2022; Georgiou et al., 2020).

Teachers' confidence in their ability to impact learning, engagement, and instructional outcomes is known as teacher self-efficacy, which is based on social cognitive theory. Exuberance, professional performance, work engagement, and psychological well-being are all associated with high self-efficacy (Rodríguez-Sánchez et al., 2011; Salanova et al., 2011). In a broader sense, self-efficacy is the conviction that one can carry out professional duties and react suitably to the difficulties that arise throughout the educational process (Mahfud et al., 2024).

Self-efficacy is particularly relevant when dealing with engineering and technical education, as teachers have to combine pedagogical competence with technical and practical experiences. Besides understanding the disciplinary principles, they have to supervise labs or workshops, show real-world applications, and communicate technical information effectively to students (Yang et al., 2024; Sasmito et al., 2020; Gagnon & Dubeau, 2023). Physical and psychological factors, social support, observation of others, and mastery experiences can all have an impact on their self-efficacy (Wangid et al., 2020).

According to earlier studies, professional engagement, instructional creativity, and teaching effectiveness are all related to educators' self-efficacy (Romijn et al., 2020). Teachers who believe they are more capable are more likely to try out novel teaching strategies, persevere through challenges in the classroom, and create learning settings that support students' technical proficiency. Higher teacher self-efficacy has also been linked to professional development, particularly in STEM fields related to engineering education (Zhou et al., 2023).

The competences required of technical educators, including the wider professional and technological competencies needed of TVET teachers, have expanded due to the growing applications of digital technology, automation, artificial intelligence, and other Industry 4.0 technologies (Shahroni et al., 2022). Innovative pedagogy, laboratory management, technology integration, and adaptable solutions for technology-rich learning settings are all included in teaching practice, which is not limited to instructional planning and technical content mastery (Hashim et al., 2024). The significance of instructional self-

efficacy and technology as elements of successful teaching practices is increased by this development.

The evidence supporting the connection between teacher self-efficacy and engineering and technical education teaching practices is dispersed across many educational contexts and research methodologies, despite the growing body of literature on the subject. Existing research has documented relationships between self-efficacy, professional competence, teaching quality, technology use, and student-related outcomes; however, a more thorough synthesis of the aspects of self-efficacy and the ways in which they impact technical teaching practices is required (Amirian et al., 2023).

Thus, this study aims to systematically review the literature to identify, analyze, and synthesize research on self-efficacy and teaching practice in engineering and technical education. This review explores the dimensions of self-efficacy related to teaching practice, the aspects of teaching that are influenced by self-efficacy, and the contextual factors that strengthen or moderate these associations. The research questions of the study are:

- (i) RQ1: How does self-efficacy influence teaching practice in engineering and technical education
- (ii) RQ2: Which dimensions of self-efficacy are most strongly associated with different aspects of technical teaching practice?
- (iii) RQ3: What contextual factors influence the relationship between self-efficacy and teaching practice in engineering and technical education?

The findings are expected to provide an evidence-based foundation for professional development, educator preparation, and institutional strategies aimed at strengthening teaching quality in engineering and technical education.

II. METHOD

The data-gathering procedure commenced with the establishment of a particular research inquiry regarding the impact of self-efficacy on pedagogical practices in engineering and technical education within higher education. A comprehensive literature search was conducted using Scopus, Web of Science (WoS), ERIC (Education Resources Information Center), and Google Scholar. The search used combinations of keywords such as “self-efficacy,” “teacher efficacy,” “teaching practice,” “vocational education,” “technical education,” “higher education,” and “teaching competence,” combined using Boolean operators (AND, OR) to maximize the relevance of the search results (Warren et al., 2021). This approach follows the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, which has become the global standard for conducting systematic reviews, ensuring that each stage of the research is carried out in a structured manner and is methodologically accountable (Orakcı et al., 2023). The use of PRISMA enables researchers to systematically document the process

of literature search, article selection, and synthesis of findings, thereby enhancing the validity and reliability of the study’s results.

A precise and well-defined research question, “How does self-efficacy affect teaching practice in the setting of vocational engineering education in university,” served as the foundation for the data collection method. Several reliable academic databases, such as Scopus, Web of Science, ERIC (Education Resources Information Center), and Google Scholar, were searched thoroughly for relevant material. This set of databases was chosen due to their recommendations for multidisciplinary educational research. While ERIC is a specialized database of educational literature that is extremely pertinent to the subject of this study, Scopus and Web of Science have access to the top international journals in the world. To maximize relevant search results, the keyword search used combination words like “self-efficacy”, “teacher efficacy”, “teaching practice”, “vocational education”, “technical education”, “higher education”, and “teaching competence” combined using Boolean operators (AND, OR) (Warren et al., 2021).

To guarantee the caliber of the articles examined, stringent inclusion criteria were set. The following criteria must be met for an article to be included in this review: it must be published between 2021 and 2025 to ensure that the data is current; it must be published in a peer-reviewed scientific journal; it must use empirical research methodologies or theoretically relevant analytical approaches that directly contributed to the synthesis of self-efficacy in technical and technology-oriented education; it must concentrate on self-efficacy in engineering, technical, vocational, teacher-education, or closely related technology integration, professional competence, or educator development. On the other hand, articles unrelated to the main issue, publications without a peer-review process (such as unindexed conference proceedings), conceptual or opinion pieces without empirical data support, and literature that is either inaccessible or not available in full text are examples of exclusion criteria. According to the PRISMA protocol, the screening procedure was carried out in three steps: database searches were used to find articles; titles and abstracts were screened to determine their initial relevance; and full-text articles were evaluated to make sure they met the inclusion criteria (Pumptow & Brahm, 2021).

In order to discover key themes, patterns of linkages, and contextual factors impacting the relationship between self-efficacy and teaching practice skills, data analysis was carried out using a narrative synthesis approach that incorporated findings from multiple studies. A thorough interpretation of the theoretical mechanisms underlying the impact of self-efficacy on teaching practice in the context of technical vocational education, cross-study comparisons to find consistency and contradictions, and thematic coding of key findings were all part of the analysis process. To ensure the transparency and reproducibility of this research for future studies, a PRISMA flowchart is used to describe the entire SLR process in detail, including the number of articles at each selection stage, the reasons for exclusion, and the

final number of articles subjected to analysis (Zhou et al., 2023).

III. RESULTS AND DISCUSSION

A. Characteristics of the Articles Reviewed

The PRISMA 2020 methodology was followed in the methodical and controlled execution of the systematic literature review procedure. 309 journal articles from Scopus, Web of Science, ERIC, and Google Scholar were found during the identification step of our literature search employing several scholarly databases. After removing duplicates, 207 distinct journal articles were found for additional screening. 112 articles met the relevance requirements for further review after titles and abstracts were evaluated for initial relevance to the research topic during the screening phase. At this point, 95 papers were eliminated due to their lack of relevance to the study's focus on teaching methods and self-efficacy in the context of technical vocational education.

112 journals in all made it past the screening phase and were evaluated in full. 56 journals were eliminated from this eligibility screening process for a variety of reasons, including the lack of full texts, subpar methodology, and failure to meet the publication period requirements between 2021 and 2025. After evaluating the eligibility of the remaining 56 journals, the following additional exclusions were made: 19 journals were excluded for the first reason (not concentrating on technical vocational education or the higher education context), and 17 journals and other methodological reasons were excluded for the second reason (not explicitly discussing the relationship between teaching practice skills and self-efficacy).

19 high-caliber scientific publications that satisfied all inclusion requirements and were suitable for in-depth examination in this systematic review were the outcome of this stringent selection procedure. Figure 1 displays the PRISMA flowchart for the entire article selection process.

Nineteen scientific articles that satisfied the inclusion criteria were chosen for in-depth examination as a result of the systematic literature review. From 2021 to 2025, the distribution of publications indicates a growing tendency in the study of self-efficacy in the context of education. The fact that the studies are geographically dispersed throughout a number of nations, including Indonesia, Australia, China, Vietnam, South Africa, and European nations, suggests that self-efficacy in technical vocational education is a global issue. A variety of methodological designs were employed, including mixed methods (10%), experimental (5%), meta-

analysis (5%), theoretical (5%), and quantitative predominance (75%). Pre-service teachers, early career teachers, university faculty, and students in technical vocational education were among the sample characteristics. The sample sizes varied from 45 to 3,159 participants, suggesting a wide range of research settings to examine. A thorough synopsis of the 19 articles examined is given in Table I.

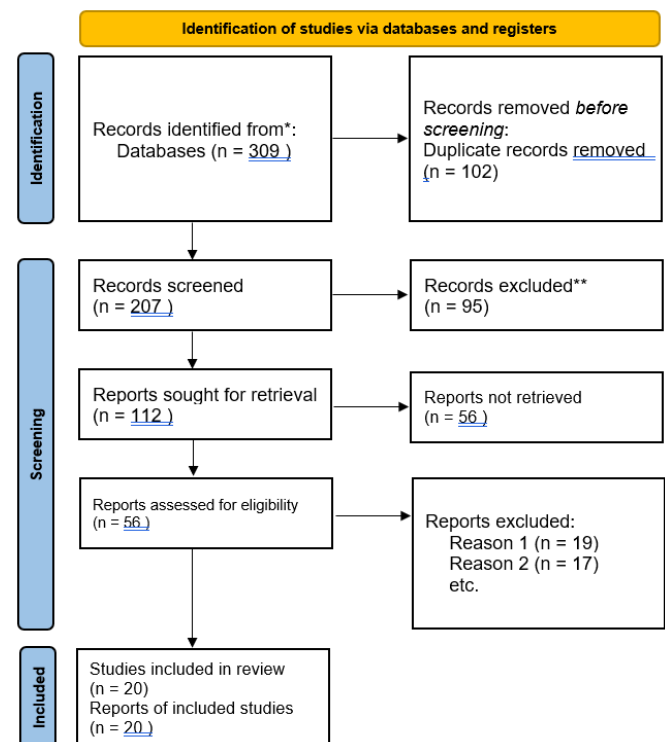


Fig. 1. PRISMA Flowchart of the Article Selection Process.

The data analysis techniques applied in these studies point to the complex relationship between self-efficacy and teaching competence. The most popular method was regression (40%), followed by Structural Equation Modeling (SEM) (25%), correlation and mediation analysis (20%), and specialized methods such as Random-Intercept Cross-Lagged Panel Modeling, Rasch analysis, and game theory (15%). This methodological diversity facilitates greater comprehension of the mechanisms through which self-efficacy influences teaching practice from different analytical perspectives.

TABLE I
CHARACTERISTICS AND MAIN FINDINGS OF THE STUDIES INCLUDED IN THE SYSTEMATIC REVIEW

No	Study	Research Focus	Design and Sample	Data Analysis	Main Findings	Relevance to the Review
1	Magenes et al. (2022)	Learning skills, creativity, and self-efficacy	Quantitative; 180 vocational high school students aged 14–17 years	Regression analysis	Self-efficacy was negatively associated with fluency but positively associated with reading accuracy.	Provides evidence on the relationship between self-efficacy and learning-related competencies in a vocational education context.
2	Barhoumi (2023)	Controlled self-learning and soft/cognitive skills	Qualitative-analytical; engineering students	Descriptive analysis	Teamwork, group discussion, and flipped learning were identified as useful	Relevant to learning approaches that may support competence development in engineering and technical education.

3	Arviv Elyashiv and Rozenberg (2024)	of engineering students Teacher preparation, self-efficacy, preparedness, and professional commitment	Quantitative; early-career teachers	Correlation and mediation analysis	approaches for developing soft and cognitive skills. Teacher-education knowledge was positively related to preparedness and self-efficacy, which contributed indirectly to professional commitment.	Directly relevant to the relationship between teacher preparation, self-efficacy, and professional readiness.
4	Garriott et al. (2021)	Engineering learning experiences and self-efficacy-related variables	Quantitative instrument development; Latinx and White engineering students	EFA, CFA, and correlation analysis	The Engineering Learning Experiences Scale identified performance accomplishments, vicarious learning, verbal persuasion, and emotional/physiological arousal as key dimensions. Stable and time-specific associations were found between teacher self-efficacy and work engagement; work engagement predicted later self-efficacy.	Supports understanding of learning experiences that contribute to self-efficacy in engineering education.
5	Burić et al. (2022)	Teacher self-efficacy and work engagement	Quantitative longitudinal; 3,010 teachers across three waves	RI-CLPM	Academic self-efficacy and learning motivation were positively associated with willingness to communicate. A three-factor self-assessment self-efficacy scale demonstrated acceptable construct and convergent validity.	Provides longitudinal evidence on the dynamic relationship between self-efficacy and professional engagement.
6	Zhang and Dai (2024)	Academic self-efficacy, motivation, and willingness to communicate	Quantitative; 303 university students in EMI classrooms	Correlation and regression analyses	Self-efficacy significantly influenced career choice and mediated relationships involving digital competence and psychological well-being. Career exploration was associated with career choice, while social support moderated specific relationships.	Provides complementary evidence on self-efficacy in university learning and communication contexts.
7	Varier et al. (2021)	Self-efficacy for self-assessment	Quantitative instrument development; two undergraduate samples (335 and 662)	EFA, CFA, and convergent validity analysis	Self-efficacy mediated the relationship between teacher collaboration and career well-being, while distributed leadership played a moderating role. Students using generative AI demonstrated higher programming self-efficacy, computational thinking, and motivation than the control group.	Illustrates the domain-specific measurement of self-efficacy in higher education.
8	Kholifah et al. (2025)	Self-efficacy and career choice in vocational education	Quantitative ex-post facto; 647 vocational education students	PLS-SEM and bootstrapping	Lifelong learning was associated theoretically with adaptability and innovation, although potential trade-offs were also identified.	Demonstrates the role of self-efficacy in professional and career development within vocational education.
9	Pham et al. (2024)	Self-efficacy, career exploration, career choice, and social support	Quantitative; 340 Vietnamese students	Regression and moderation analysis	Interventions produced a medium overall effect on teacher self-efficacy; lesson-	Provides contextual evidence on self-efficacy-related career processes and social influences.
10	Klassen et al. (2023)	Scenario-based intervention and pre-service teacher self-efficacy	Longitudinal intervention; 1,513 prospective teachers	Latent change analysis		Strongly relevant to intervention-based development of self-efficacy in teacher preparation.
11	Suyatmo et al. (2025)	Lecturer behaviour, student motivation, and competence development	Quantitative; 229 final-year aviation polytechnic students	SEM		Links lecturer behaviour with student motivation and competence development in technical education.
12	Wang et al. (2025)	Teacher collaboration, self-efficacy, distributed leadership, and career well-being	Quantitative; 3,159 teachers	Moderated mediation analysis		Relevant to institutional and collaborative factors supporting teacher self-efficacy.
13	Yilmaz and Yilmaz (2023)	Generative AI, programming self-efficacy, computational thinking, and motivation	Experimental pretest-posttest; 45 undergraduate students	Comparative statistical analysis		Provides evidence on technology-supported development of self-efficacy in technical learning.
14	Zuo et al. (2025)	Lifelong learning, innovation, and vocational education	Theoretical game-theory model	Game-theory analysis		Provides a systemic perspective on lifelong learning and adaptability in vocational education.
15	Yee et al. (2023)	Interventions supporting pre-service and	Meta-analysis; 28 studies and 49 effect sizes	Meta-analysis		Provides strong synthesis evidence on strategies for developing teacher self-efficacy.

16	Kruskopf et al. (2024)	beginning teachers' self-efficacy Self-efficacy in teaching practical and algorithmic ICT competencies	Quantitative; two teacher-training cohorts (n = 347 and n = 428)	Regression analysis	plan feedback strengthened intervention effects. Self-efficacy differed according to ICT competence, age, gender, science background, and prior ICT learning.	Relevant to technological self-efficacy and background factors among future teachers.
17	Paetsch et al. (2023)	Teacher self-efficacy, ICT literacy, and technology use	Quantitative; early-career teachers	Path analysis	ICT literacy, general teacher self-efficacy, and teaching experiences were associated with technology-integration self-efficacy and technology use.	Directly relevant to technological self-efficacy and technology integration in teaching practice.
18	Noben et al. (2021)	Professional development, university teacher self-efficacy, and teaching conceptions	Mixed methods; university lecturers participating in a 5-ECTS professional development program	Pre-post survey, paired-samples t-test, reflection, and interviews	Professional development increased reported self-efficacy and was associated with movement toward more student-centred teaching conceptions.	Directly supports the role of professional development in strengthening educator self-efficacy.
19	Simba et al. (2025)	Digital self-efficacy, technostress, and entrepreneurial behaviour	Quantitative; 643 early-stage entrepreneurs	Regression analysis	Digital self-efficacy was associated with perceived behavioural control and technostress, while some relationships involving entrepreneurial outcomes were inconclusive.	Provides complementary evidence on digital self-efficacy in technology-intensive professional contexts.

B. Dimensions of Self-Efficacy in Vocational Education Engineering

An analysis of the reviewed literature identified five main dimensions of self-efficacy relevant to the context of technical vocational education. First, personal teaching efficacy is an individual's belief in their own teaching ability, which has been shown to have a strong correlation with the quality of teaching practice. Research confirms that the development of a self-efficacy measurement instrument for pre-service teachers during their internship program in Indonesia showed that the Instructional Self-Efficacy domain received the highest score, indicating that pre-service teachers have strong confidence in their ability to deliver instructional content. The second dimension is outcome expectancy-or expectations regarding teaching outcomes-which influences teachers' persistence and effort in addressing learning challenges. The third dimension, which is particularly important in the digital age, is technological self-efficacy, or confidence in using educational technology. Studies show that teachers' ICT literacy and general self-efficacy have a significant impact on technology integration self-efficacy, which in turn influences changes in the use of technology for teaching (Paetsch et al., 2023). These findings are reinforced by other research that identifies practical ICT competencies-such as device and data management-as well as algorithmic competencies-such as programming and data security-as key components of future teachers' self-efficacy. The fourth dimension is subject matter self-efficacy-or confidence in mastering technical content-which serves as a critical foundation for vocational educators who must integrate theoretical knowledge with practical applications. The fifth dimension is instructional self-efficacy, encompassing confidence in applying effective learning strategies to facilitate students' understanding of complex technical concepts.

C. Aspects of Teaching Practice Affected

Self-efficacy has been shown to influence various aspects of teaching practice in technical vocational education. In terms of instructional planning. Interventions that include feedback on lesson plans can strengthen the self-efficacy of pre-service and beginning teachers, although the moderating effect of lesson-plan feedback fell slightly short of statistical significance (Yee et al., 2023). This indicates that the lesson planning process, when accompanied by constructive feedback, can enhance teachers' confidence in their ability to design effective learning experiences. The delivery of both theoretical and practical instruction is also strongly influenced by self-efficacy, with teachers who have high self-efficacy tending to be more innovative in applying contemporary methods.

Classroom and laboratory management are aspects of teaching practice that require strong self-efficacy, particularly in the context of vocational education, which involves the management of technical equipment and workplace safety. The "Efficacy in Creating a Positive School Atmosphere" domain showed the lowest scores among prospective teachers, indicating the need for specific reinforcement in the area of managing the learning environment. The use of learning media and technology is becoming an increasingly crucial aspect. Experimental evidence indicates that generative AI-based tools can support students' programming self-efficacy in technology-oriented learning contexts (Yilmaz & Yilmaz, 2023). Learning evaluation and assessment require adequate self-efficacy so that instructors can design and implement valid and reliable assessments of students' technical competencies. Innovation in teaching methods is highly dependent on self-efficacy, where controlled self-learning methods through teamwork, group discussions, and the flipped classroom have proven to be best practices for

enhancing engineering students' soft skills and cognitive skills. The management of laboratory sessions and workshops requires a high level of self-efficacy given the technical complexity and safety aspects that must be managed simultaneously.

D. The Relationship Between Self-Efficacy and Teaching Skills

The relationship between self-efficacy and teaching practice skills shows strong consistency across the reviewed literature. A significant positive relationship was found across various contexts, where knowledge acquired during teacher preparation showed a direct positive correlation with early-career teachers' sense of preparedness and self-efficacy, which indirectly contributed to professional commitment through the mediation of these two factors (Arviv Elyashiv & Rozenberg, 2024). The strength of the correlation varies depending on the dimensions of self-efficacy and the aspects of teaching practice measured, with some studies reporting medium to large effect sizes.

Mediating and moderating variables play a crucial role in these relationships. Teachers' self-efficacy has been shown to mediate the relationship between teacher collaboration and career well-being, while distributed leadership moderates relationships involving teacher collaboration, career well-being, and self-efficacy (Wang et al., 2025). In the context of career exploration, social support has a negative impact on the relationship between environmental exploration and career choice, indicating the complexity of interactions among variables in influencing self-efficacy. Differences based on teaching experience show that teachers with positive experiences have higher technology integration self-efficacy, which influences changes in the use of ICT for teaching.

Differences based on fields of engineering expertise were also identified. Differences associated with background characteristics were also identified, with age, gender, and prior science-related experience associated with self-efficacy in teaching practical and algorithmic ICT competencies (Kruskopf et al., 2024). These findings highlight the need to tailor approaches to developing self-efficacy based on teachers' demographic and academic characteristics.

TABLE II
SUMMARY OF THE RELATIONSHIP PATTERN BETWEEN SELF-EFFICACY AND PRACTICE TEACHING.

Relationship Aspects	Key Findings	Power of Effect	Source
Teacher knowledge → Self-efficacy	Direct positive correlation	Significant	Arviv Elyashiv & Rozenberg (2024)
Teacher collaboration → Career well-being	Mediated by self-efficacy	Significant	Wang et al. (2025)
Online intervention → Self-efficacy of prospective teachers	Significant and sustained improvement	Medium-Large	Klassen et al. (2023)
Professional development → Lecturer self-efficacy	Significant overall improvement	Significant	Noben et al. (2021)

ICT literacy → Technology integration efficacy	Direct and indirect influences	Significant	Paetsch et al. (2023)
Feedback lesson plans → Self-efficacy.	Strengthening the effects of interventions	Big	Yee et al. (2023)

E. Factors that Influence Teacher Self-Efficacy

Identifying the factors that influence teachers' self-efficacy is a key finding of this literature review. Mastery experience-or experiences of success in teaching-is the strongest predictor of self-efficacy. The Engineering Learning Experiences Scale (ELES), consisting of 22 items, measures four sub-factors that serve as sources of self-efficacy in social cognitive theory: performance accomplishments, vicarious learning, verbal persuasion, and emotional/physiological arousal. This instrument demonstrates that structured learning experiences contribute significantly to the development of self-efficacy among engineering students.

Training and professional development have proven effective in enhancing teachers' self-efficacy. A 5-ECTS professional development program for university faculty resulted in an overall increase in reported self-efficacy beliefs and changes toward more student-centred teaching conceptions (Noben et al., 2021). Online scenario-based learning interventions have also demonstrated effectiveness in enhancing self-efficacy, teaching commitment, and perceptions of professional fit among pre-service teachers, with lasting effects for self-efficacy and perceptions of professional fit, though not for teaching commitment.

Support from institutions and colleagues plays a vital role in the development of self-efficacy. Teacher collaboration is significantly and positively correlated with teachers' career well-being and self-efficacy, with self-efficacy mediating the relationship between teacher collaboration and career well-being (Wang et al., 2025). Industry experience is a key factor, particularly in technical vocational education, where alignment between practical experience and instructional content can enhance teachers' confidence in the relevance of the material they present. Educational background alignment also influences self-efficacy, particularly in the domain of subject matter efficacy, where teachers with educational backgrounds that align with their teaching fields tend to have higher self-efficacy.

F. The Influence of Self-Efficacy on Teaching Practice Skills

The self-efficacy of an educator is a main factor that drives teaching performance in technical higher education. From the social cognitive perspective, these efficacy beliefs influence an instructor's degree of persistence, problem-solving strategies, and overall effort in the face of instructional challenges. In technical fields where classroom theory has to be directly connected to hands-on technical implementation, faculty with high self-efficacy are considerably more prone to utilize student-centered approaches and structured self-learning protocols (Barhoumi, 2023; Arviv Elyashiv & Rozenberg, 2024).

Teachers with high self-efficacy tend to set more ambitious learning goals, are more persistent in the face of obstacles during the teaching process, and experience lower stress levels when facing challenging teaching situations. The specific context of technical vocational education adds to the complexity because instructors have to have dual self-efficacy: confidence in their technical competence and confidence in their pedagogical ability to transfer that technical knowledge to students.

G. *The Most Influential Dimensions of Self-Efficacy*

An analysis of the most influential dimensions of self-efficacy in the context of engineering education shows that technological self-efficacy is becoming increasingly dominant in the Industry 4.0 era. Teachers' ICT literacy and general self-efficacy have been associated with technology-integration self-efficacy, which in turn is related to changes in technology use for teaching (Paetsch et al., 2023). This indicates that in modern technical vocational education, instructors' ability to integrate digital technology is a critical factor distinguishing effective teaching practices from conventional ones. The importance of subject matter efficacy for vocational instructors cannot be overlooked, given that the credibility and effectiveness of technical instruction depend heavily on a deep mastery of the content. The Instructional Self-Efficacy domain, which showed the highest scores among Indonesian pre-service teachers, indicates that teacher preparation programs have successfully built confidence in instructional delivery; however, other aspects - such as creating a positive school atmosphere need to be strengthened. The integration of pedagogical and technical efficacy is a unique characteristic of effective vocational educators, where both dimensions must develop simultaneously and reinforce one another.

H. *Implications for Teaching Practices in Engineering Education*

Although general pedagogical competence is important, empirical evidence shows that faculty self-efficacy is a major factor influencing instructional delivery, laboratory management, and the adoption of innovative pedagogies such as flipped learning and generative-AI-supported instruction in engineering and technical education (Barhoumi, 2023; Paetsch et al., 2023; Yimaz et al., 2023). The contribution of self-efficacy to the development of student competencies is not limited to technical aspects but also encompasses soft skills, which are increasingly important in the workplace. Instructors' behavior significantly enhances students' self-motivation, which in turn contributes to the development of both soft and hard skills. The relevance to industry demands becomes even clearer when instructors with high self-efficacy are able to bridge the gap between academic learning and the practical needs of the workplace, preparing graduates who are truly ready to face industry challenges.

I. *Contextual and Moderator Factors*

The literature has consistently reported that teaching experience strengthens self-efficacy. Longitudinal studies show a positive relationship between the stable components

of teachers' self-efficacy and work engagement, and a spillover effect of work engagement on teachers' self-efficacy (Burić et al., 2022). This means that positive teaching experience and work engagement form a reinforcing cycle that sustainably enhances self-efficacy. The effect of training and professional development programs has been demonstrated to be significant, as systematically planned programs can generate measurable and sustained gains in self-efficacy over a specified period of time. The finding that distributed leadership in higher education institutions positively moderates the association between faculty collaboration and career well-being and self-efficacy (Wang et al., 2025) shows the contribution of institutional support. The effect of collaboration with industry is an especially pertinent factor in vocational education where exposure to current industry practices can enhance instructors' self-efficacy in delivering relevant and contextual content.

J. *Research Gap and Recommendations*

The identification of gaps in the reviewed literature points to several areas requiring further research. First, there is still a limited body of research exploring the specific mechanisms by which self-efficacy influences detailed aspects of teaching practice in the context of laboratories and workshops in technical vocational education. Second, longitudinal studies tracking the development of teachers' self-efficacy from the preparatory phase through to later stages of their careers remain very limited, even though understanding these developmental trajectories is crucial for designing timely interventions. Areas requiring further research include an exploration of context-specific factors in Indonesia related to the development of self-efficacy among vocational education instructors, given that differences in educational systems, organizational culture, and student characteristics can influence the dynamics of self-efficacy. Limitations of the reviewed studies include the predominance of quantitative research, which may not capture the complexity of teachers' subjective experiences in developing their self-efficacy, as well as the scarcity of experimental studies that could provide stronger causal evidence regarding the effectiveness of specific interventions. Suggestions for future research include the development of mixed-methods studies that combine the strengths of quantitative analysis with the depth of qualitative understanding; design-based intervention studies that iteratively test models of self-efficacy development; and cross-institutional and cross-national comparative studies to understand the contextual factors that influence the effectiveness of self-efficacy development strategies for vocational engineering teachers.

K. *Practical Implications for Development Teachers*

The literature is synthesized to provide a basis for in-depth recommendations for a program to improve lecturers' self-efficacy. A program of this sort should include elements of mastery experiences via guided teaching practice with constructive criticism, vicarious learning through observation and mentoring by experienced instructors, verbal persuasion via support and encouragement from peers

and supervisors, and management of emotional arousal through coping methods and structured self-reflection. Evidence-based professional development strategies should focus on elements that have been validated to improve self-efficacy, such as feedback on lesson plans, scenario-based learning interventions, and collaborative programs for sharing best practices among instructors. Institutional policies supporting teacher efficacy should include: adequate resource provision, creation of a collaborative culture, implementation of distributed leadership, and a recognition system that recognizes efforts toward learning innovation. The suggested model for the professional development of technical vocational educators includes the integrated development of technical and pedagogical effectiveness, the provision of exposure to current industry practices, the development of digital technology competencies, and the establishment of sustainable support systems that meet the individual developmental needs of educators at different stages of their careers.

L. Formulation of Hypothesis

Based on the synthesis of findings from the systematic literature review, several hypotheses can be formulated for future empirical studies examining self-efficacy and teaching practice in engineering and technical higher education in Indonesia:

- H1: Lecturer self-efficacy has a significant positive effect on teaching practice skills at universities offering technical vocational education
- H2: Technological self-efficacy has the most dominant influence on teaching practice ability compared to the self-other efficacy dimensions in the context of vocational engineering in the Industry 4.0 era.
- H3: Work engagement mediates the relationship between self-efficacy and the quality of teaching practice among technical vocational education faculty members.
- H4: A structured professional influence is positively and significantly related to self-efficacy in vocational engineering teacher education.
- H5: Experience teach moderate connection between efficacy self and abilities practice teaching, where longer experience strengthens influence positive efficacy self to practice teach.
- H6: Support institutions moderate the connection between collaboration between lecturers and self-efficacy in the context of education vocational engineering in college tall.
- H7: Subject matter self-efficacy and instructional self-efficacy are simultaneously related and simultaneously influential to innovation method learning in vocational engineering education.

These hypotheses were developed based on patterns of consistent findings in the reviewed literature and may be used as a basis for further empirical research using quantitative, qualitative, or mixed-methods designs to validate and deepen our understanding of the dynamics of self-efficacy and teaching competence in the specific context of technical vocational education in Indonesia.

CONCLUSION

A systematic literature review of 19 scientific articles published between 2021 and 2025 reveals that self-efficacy is positively related to teaching practices in engineering and technical education. Five major dimensions were identified: personal teaching efficacy, outcome expectancy, technological self-efficacy, subject-matter self-efficacy, and instructional self-efficacy. Among these dimensions, technological self-efficacy has become increasingly important in technology-rich learning environments associated with Industry 4.0.

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