

Systematic Literature Review: Self-Efficacy in STEM-Oriented Technical and Vocational Education and Training (TVET)

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Abstract

In the context of Information 4.0, STEM-oriented Technical and Vocational Education and Training (TVET) has emerged as a crucial pathway for developing learners' technical expertise and advanced competencies. Self-efficacy is also seen as a key factor that affects how both students and teachers participate, adapt, and do well in this area. This systematic review aims to investigate both the theoretical framework and the practical application of self-efficacy in STEM-oriented TVET. Fifteen empirical studies were chosen and carefully examined in accordance with PRISMA 2020 standards. The results indicate that most studies are based on Bandura's Social Cognitive Theory (SCT), with several also utilising frameworks like the Social Cognitive Career Theory (SCCT). Self-efficacy is expressed in three primary dimensions: academic-oriented, task-specific technological, and career-directed. Research shows that self-efficacy helps students stick with their studies, learn new skills, and

get ready for careers. It also helps teachers use new teaching methods and effectively combine STEM education. These results highlight the significance of self-efficacy as both a theoretical construct and a practical instrument, offering valuable insights for curriculum development, student learning, teacher training, and policy formulation in STEM-oriented TVET.

Keywords: Self-efficacy, Academic self-efficacy, Teaching self-efficacy, STEM education, Technical and Vocational Education and Training (TVET), STEM-Oriented TVET, Systematic review

1. Introduction

Technical and Vocational Education and Training (TVET) is a big part of education that helps students learn practical skills and professional skills that are in line with the needs of the job market and changes in society (UNESCO, 2022). The rapid growth of digital technology and the start of the Fourth Industrial Revolution have made it necessary for STEM (Science, Technology, Engineering, and Mathematics) fields to be more closely linked to the TVET system. This method, which is often called STEM-oriented TVET, emphasises the combination of knowledge from different fields with hands-on experience. This makes it easier for students to adapt to new technologies and helps them develop their creative potential (Dixon & Hutton, 2016; Li et al., 2020). In this model, vocational curricula include engineering technologies, applied mathematics, and scientific inquiry. These subjects are taught using methods like project-based and inquiry-based learning, as well as digital tools like virtual reality (VR) and augmented reality (AR).

STEM-oriented TVET not only teaches students skills that will help them in their jobs, but it also teaches them higher-level skills like problem-solving, critical thinking, teamwork, and creativity, which are all important for dealing with industrial situations that are getting more complicated (English, 2016; Azeem et al., 2021). Teachers' jobs have changed from just teaching technical skills to also being cross-disciplinary integrators and innovation facilitators. Teacher self-efficacy significantly influences curriculum integration, instructional quality, and the cultivation of students' professional identity (Tschannen-Moran & Hoy, 2001; Sublett et al., 2022).

Thus, STEM-oriented TVET is not just a mix of vocational training and STEM subjects; it is a new way of teaching that aims to create a workforce that is technically skilled, creative, and flexible. Within this paradigm, self-efficacy stands out as a critical construct: the beliefs that students and teachers hold regarding their own capabilities substantially affect learning motivation, instructional effectiveness, and long-term career trajectories.

Despite the rising emphasis on STEM within vocational education, research on self-efficacy in this context remains fragmented. Most studies examine either learners or teachers in isolation, lacking a comprehensive perspective on their interconnected roles. In addition, theoretical approaches vary considerably—from Bandura's Social Cognitive Theory (SCT) to task-specific or domain-specific frameworks—resulting in conceptual fragmentation that constrains theoretical accumulation and practical application (Klassen et al., 2011).

This review seeks to consolidate the current empirical findings about STEM-oriented TVET self-efficacy, concentrating on two fundamental questions:

RQ1: Which dimensions and theoretical frameworks of self-efficacy have been examined in the setting of STEM-oriented TVET?

RQ2 How does self-efficacy impact learning outcomes and teaching in STEM-oriented TVET contexts?

By systematically exploring these questions, this review not only clarifies the fragmented state of existing scholarship but also identifies gaps in theory, methodology, and practice. In doing so, it aims to provide insights for policymakers, educators, and researchers, positioning self-efficacy as a cornerstone for advancing high-quality and equitable STEM-oriented TVET.

2. Methods

2.1 Literature Search

This review was executed in alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020; Page et al., 2021). A thorough search was conducted across four principal electronic databases: Scopus, ERIC, Web of Science (WoS), and ProQuest. The search strategy incorporated three primary clusters of keywords, interconnected by Boolean operators: (1) self-efficacy, including variations like "academic self-efficacy," "teaching self-efficacy," and "learning self-efficacy"; (2) vocational education, encompassing "technical and vocational education" (TVET), "career and technical education" (CTE), and associated terminology; and (3) STEM fields, comprising "science," "technology," "engineering," and "mathematics." The search queries were changed to fit the different indexing rules and search syntaxes of each database, but the logical structure stayed the same. For example, Scopus used TITLE-ABS-KEY fields, WoS used TS fields, ERIC used descriptor and keyword searches, and ProQuest used NOFT commands. Table 1 has a full list of search strings for each database. Only peer-reviewed journal articles were used to make sure the evidence base was reliable. Dissertations, reports, and conference proceedings that are not published in books or journals were not included. There were no limits on the year of publication, but only studies published in English were eligible.

Table 1. Search terms

Database	Search terms
ProQuest	NOFT("self-efficacy") AND NOFT("TVET" OR "vocational education" OR "technical education") AND NOFT("STEM" OR "science education" OR "engineering education") AND NOFT(teacher* OR student* OR educator*) AND NOFT("systematic review" OR "quantitative")

Educational Resources Information Center (ERIC)	("self efficacy" OR "self-efficacy") AND ("vocational education" OR "technical education" OR "career and technical education" OR "TVET") AND ("STEM" OR "science education" OR "technology education" OR "engineering education" OR "mathematics education")
Web of Science (WoS)	TS=("self-efficacy" OR "self efficacy") AND TS=("technical and vocational education" OR "vocational education and training" OR "TVET" OR "career and technical education") AND TS=("STEM" OR "science" OR "technology" OR "engineering" OR "mathematics")
Scopus	TITLE-ABS-KEY("self-efficacy" OR "academic self-efficacy" OR "teaching self-efficacy" OR "learning self-efficacy") AND TITLE-ABS-KEY("technical and vocational education" OR "TVET" OR "vocational education" OR "technical education" OR "career and technical education" OR "CTE") AND TITLE-ABS-KEY("STEM" OR "science education" OR "technology education" OR "engineering education" OR "mathematics education")

2.2 Literature Screen And Selection

To maintain both rigor and relevance, explicit eligibility criteria were established for the screening process. Studies were considered suitable for inclusion if they directly investigated self-efficacy in the context of STEM-related technical and vocational education, either among students or teachers. Empirical research adopting quantitative, qualitative, or mixed-method designs was eligible, provided the work appeared in peer-reviewed journals and was published in English. By contrast, studies were excluded if they dealt with general constructs such as self-concept or self-esteem rather than self-efficacy, lacked measurable outcomes, or were unrelated to STEM within a vocational education framework. Non-empirical works and grey literature were also filtered out to ensure consistency in evidence quality.

The database searches initially yielded 156 records. After removing 5 duplicates, 151 unique publications remained. Applying the inclusion and exclusion criteria led to the elimination of 136 studies, leaving 15 articles that met the requirements for review. The full selection process is depicted in the PRISMA flow diagram (Figure 1), which illustrates how the initial pool of texts was systematically narrowed down to the final set of studies.

Table 2. The exclusion and inclusion criteria

Inclusion Criteria	Exclusion Criteria
1. Studies focused on self-efficacy in STEM-related TVET or vocational contexts	1. Studies not involving STEM-related content (e.g., pure humanities or generic TVET)

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|---|--|
| <p>2. Empirical studies (quantitative, qualitative, or mixed-methods)</p> <p>3. Research on learners (students/apprentices) or educators in TVET/STEM</p> <p>4. Published in peer-reviewed journals</p> | <p>2. Articles focusing only on general self-concept or self-esteem, not efficacy</p> <p>3. Opinion pieces, editorials, dissertations, or book reviews</p> <p>4. Studies that do not provide data related to self-efficacy outcomes</p> <p>5. Studies outside the TVET/STEM domain</p> |
|---|--|

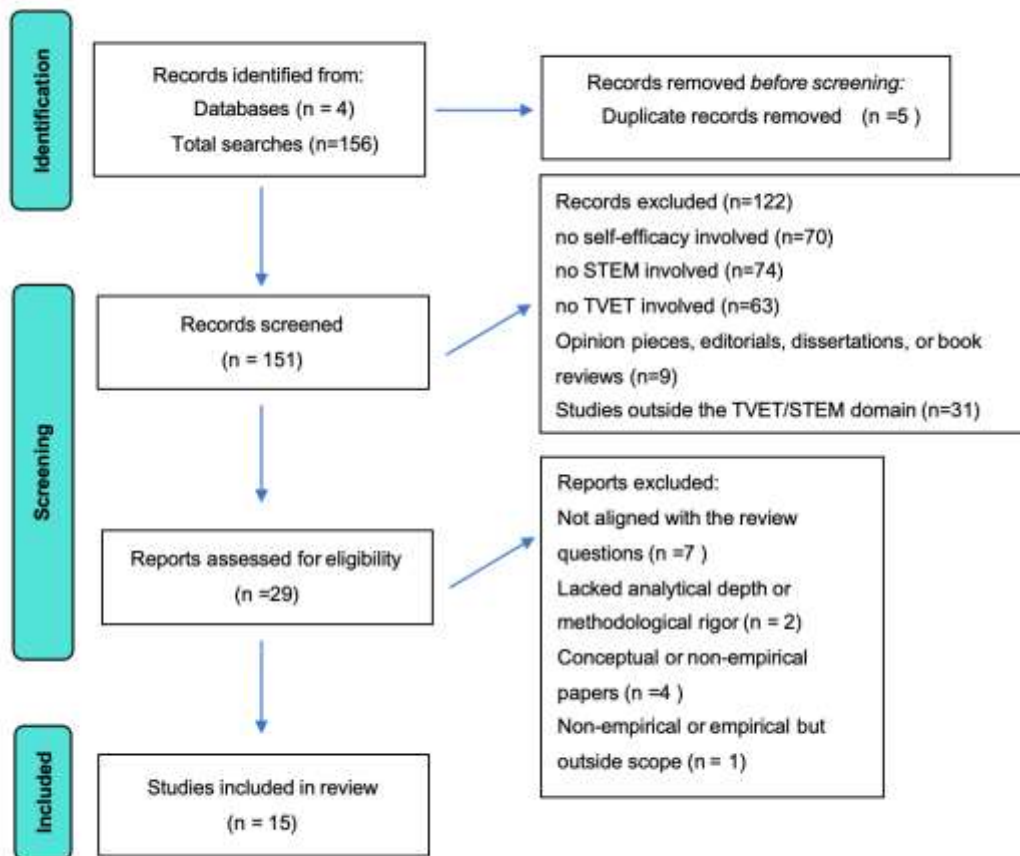


Figure 1. PRISMA 2020 flow diagram

2.3 Quality Assessment

To ensure methodological rigor and reliability, all fifteen included studies were evaluated using the Mixed Methods Appraisal Tool (Hong et al., 2018). This instrument was selected because it accommodates a range of research designs—qualitative, quantitative (descriptive and non-randomized), and mixed-methods—thereby aligning with the methodological diversity of the reviewed studies on self-efficacy in STEM-oriented TVET contexts. Each

study was assessed against five MMAT criteria, with responses coded as Yes, No, or Cannot tell. The evaluation was carried out independently by two reviewers, and any disagreements were resolved through discussion and consensus. Importantly, no study was excluded solely due to low MMAT scores; instead, the appraisal outcomes were used to contextualize the strength and credibility of evidence when synthesizing findings.

A total of 75 appraisal units were generated (15 studies \times 5 criteria). Inter-rater reliability was calculated to further verify the consistency of assessments. Agreement was observed in 65 out of 75 units (86.7%), yielding a Cohen's κ of 0.679, which represents substantial agreement (Landis & Koch, 1977). Discrepancies were documented in the quality-assessment table to maintain transparency and traceability in the review process.

Table 3. Inter-rater Reliability Test Results

Metric	Value
Total cells (N)	75
Observed agreement (P_o)	$65 / 75 = 0.867$
Expected agreement by chance (P_e)	0.586
Cohen's κ	0.679

3. Results

This review ultimately incorporated fifteen empirical studies focusing on self-efficacy in STEM-oriented Technical and Vocational Education and Training (TVET). From each publication, essential information was systematically extracted, including the authorship and year of publication, country or region, journal, methodological design, sample characteristics, self-efficacy dimension, and principal findings (Table 4). The methodological approaches varied, encompassing predominantly quantitative studies ($n=12$), along with two mixed-methods designs and one qualitative study (Figure 4). The selected works represent a wide geographical scope, with contributions from the United States ($n=6$), Chile ($n=2$), and one study each from China, Taiwan, Ghana, Turkey, Nigeria, Switzerland, and Malaysia (Figure 2). In terms of chronology, the studies span publications between 2010 and 2025 (Figure 3). This diversity in geography, institutional settings, and methodological approaches underscores both the international significance of self-efficacy in STEM-oriented vocational education and the increasing scholarly engagement with the topic over the past 15 years.



Figure 2. Research Country Affiliation

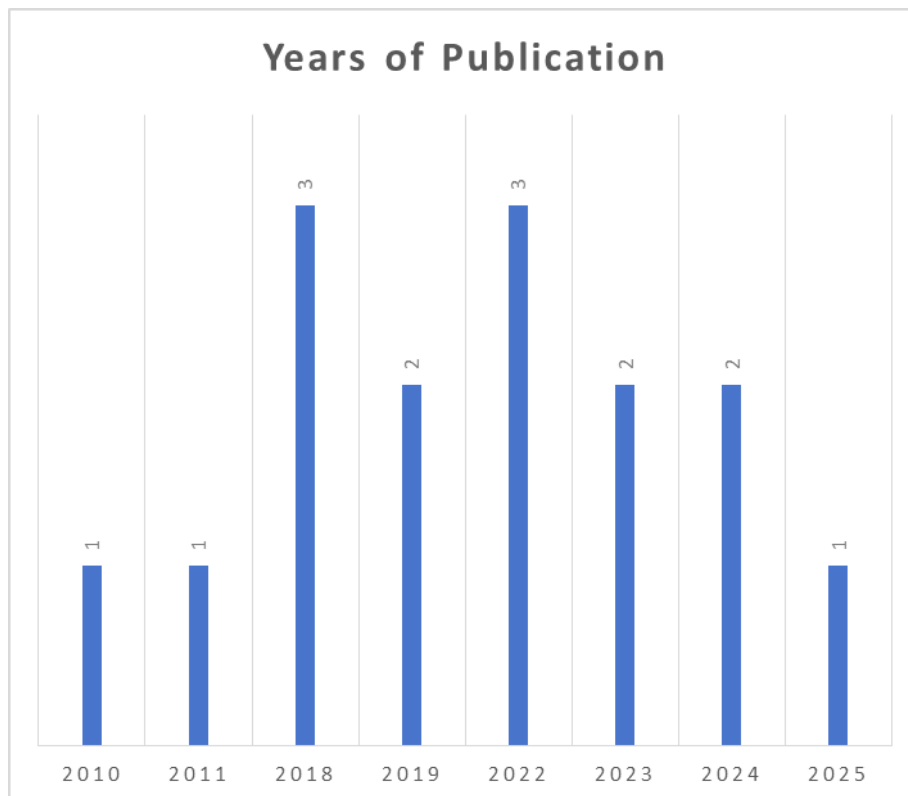


Figure 3. Years of Publication

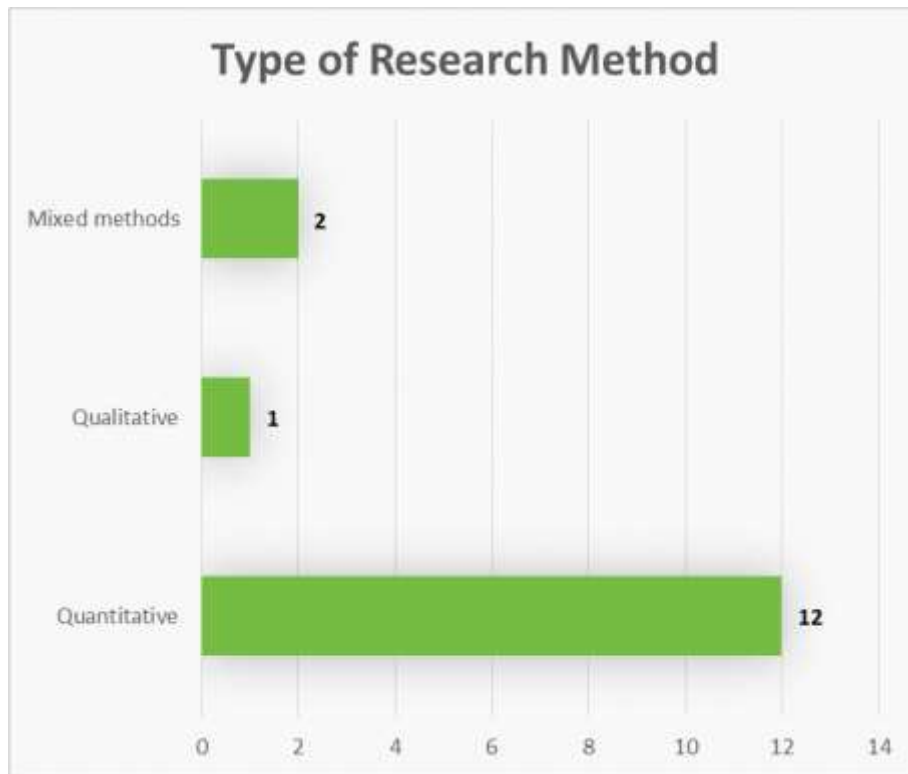


Figure 4. Type of Research Method

Table 4. Characteristics of the reviewed studies

Author(s) Year	and	Country/Region	Journal	MMAT Scores	Methodology	Sample	Self-efficacy dimension	Findings
María Sevilla, Snodgrass Rangel, Gonzalez (2022)	Paola	Chile	Journal of Education and Work	****	Qualitative	32 female students		In STEM-TVET pathways, female students' career choices and persistence are primarily driven by interest, utility value, and self-efficacy, yet their self-efficacy is often constrained by gender stereotypes and experiences of discrimination. Moreover,

								different sectors demonstrate distinct motivational belief patterns, reflecting the complex role of educational and industrial contexts in shaping women's STEM career development.
Mar'ia Paola Sevilla, Snodgrass Rangel (2023)	Chile	Journal of Career Development	****	Quantitative	698	STEM students in their second year of STEM-VTE studies	Academic Confidence, Social Comparison Beliefs, Gender Role Congruence	This study confirmed that SCCT effectively explains career development in Chilean VTE-STEM programs, showing that VTE-STEM tracks can enhance students' self-efficacy, with gender differences indicating that male students benefit more from teacher support and VTE-STEM specialization, while females gain more modest self-efficacy improvements.
Mustafa Sirakaya, Ebru Kilic Cakmak (2018)	Turkey	International Journal for Research in Vocational Education	****	Quantitative	46	TVET students	Cognitive Confidence, Performance Confidence, Technological	In TVET contexts, augmented reality (AR) applications enhance students' learning outcomes

		and Training				Engagement Confidence	and practical efficiency in computer hardware courses, but they do not significantly improve self-efficacy related to hardware assembly.
Yarhands Dissou Arthur, Thomas De Vittori, Natalie B. Welcome, Courage Simon Kofi Dogbe, Bright Asare (2025)	Ghana	Journal of Applied Research in Higher Education	****	Quantitative	219	TVET students Cognitive Understanding Efficacy, Problem-Solving Efficacy, Application & Communication Efficacy	Integrating the history of mathematics into teaching in TVET significantly enhanced students' mathematics self-efficacy, which in turn positively mediated their interest in mathematics, highlighting the role of self-efficacy as a key mechanism linking STEM-related pedagogy and student motivation.
Jay S Plasman, Michael Gottfried and Jennifer Freeman, Shaun Dougherty (2022)	USA	Policy Futures in Education	****	Quantitative	Nationally representative longitudinal sample of U.S. high school students (HSLs, 2009 cohort)	Participation in high school Computer Science Career and Technical Education (CS-CTE) fosters STEM self-efficacy and	

identity among students, benefiting both general and SWLD populations, though with differing mechanisms, highlighting important policy implications for equity and persistence in the STEM/TVET pipeline.

Cameron Sublett, Jay Stratte Plasman (2018)	USA	Journal of **** Career and Technical Education	Quantitative	Nationally representative longitudinal sample of U.S. high school students (HSLs, 2009 cohort)	STEM Subject Confidence, CTE Task Confidence, Career-Oriented Self-Efficacy	Applied STEM courses can enhance high school students' math and science self-efficacy, with the effect being more pronounced for male students, while the gains are less evident for female students and those with learning disabilities (SWDs). This reveals gender and group disparities in educational pathways, highlighting the need for policy-level interventions to improve equity and effectiveness
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Shao-Rui Xu, China Shao-Na Zhou (2024)	Journal of **** Baltic Science Education	Quantitative	464 university students	in STEM and TVET. Different educational pathways shape students' differences in STEM attitudes, self-efficacy, and career interests. University education is more effective in enhancing STEM self-efficacy and career interests in the field of science, whereas TVET education has greater advantages in cultivating attitudes and career interests toward engineering and technology.
Jon-Chao Hong, Taiwan Jian-Hong Ye, Jing-Yun Fan (2019)	Journal of **** Mathematics, Science and Technology Education	Quantitative	197 students	Integrating STEM into TVET-related fashion design education was found to enhance students' STEM knowledge and creative performance, with creative self-efficacy playing a significant mediating role.

Zaleha Endot, Malaysia Rahimah Jamaluddin (2023)	Journal of Technical Education and Training	****	Quantitative	368	RBT teachers	The study found that TVET teachers' readiness to implement RBT instruction is strongly influenced by self-efficacy and intrinsic motivation, highlighting the need to integrate these factors into teacher training programs to enhance STEM-related teaching effectiveness.
Victoria P. USA Whitley, Travis D. Park, Wendy J. Warner, Erin T. Horne (2019)	Career and Technical Education Research	****	Quantitative	22 students		During the practicum of TVET preservice teachers, self-efficacy levels fluctuated due to feedback, teaching tasks, and assessment pressures, and the study found that changes in student teachers' self-efficacy were negatively correlated with their edTPA teaching performance.
LaToya Chandler, Shellie Banfield, Page	Community College Journal of	****	Mixed methods	141 students		In the project-based STEM course

Jerzak (2024)	Research and Practice						(GRRRATE), TVET students enhanced their mathematics and science self-efficacy, STEM attitudes, and interest in related careers through teacher support and hands-on mastery experiences, although uncertainty about pursuing STEM careers remained.
A. Christian Morgan, Parr, Fuhrman (2011)	USA Career and Technical Education	Journal of Career and Technical Education	****	Mixed methods	44 teachers	of mathematics and CTE	This study shows that while CTE teachers value collaboration through the Math-in-CTE Model and demonstrate self-efficacy in cross-disciplinary STEM-TVET integration, barriers such as time, terminology, and technology access limit implementation.
Chandra Austin (2010)	USA Career and Technical Education Research	Career and Technical Education Research	****	Quantitative	396 students	Accurate self-appraisal, gathering occupational information, goal selection, planning, problem-solving	This study found that math/science self-efficacy is the strongest predictor of African American high school students' career decision

Ikechukwu

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(2023)

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4. Discussion

Self-efficacy has long been regarded as a cornerstone of educational psychology, and its role within STEM-oriented Technical and Vocational Education and Training (TVET) is both pivotal and multifaceted. With the global economy placing increasing emphasis on STEM competencies for workforce preparedness, understanding how self-efficacy shapes learning, teaching, and career development in vocational contexts has become an enduring challenge. The difficulty lies not only in capturing the complexity of self-efficacy across diverse educational settings, but also in reconciling different theoretical perspectives and methodological approaches.

This review integrated findings from fifteen empirical studies to elucidate the mechanisms of self-efficacy within STEM-oriented TVET. The analysis showed that researchers have looked at self-efficacy from many different angles, using different frameworks to show different parts of the construct. These viewpoints converge on a common understanding: self-efficacy profoundly affects the perceptions of learners and educators regarding their capacity to tackle technical and scientific tasks. More specifically, it underpins students' confidence in mastering complex skills, supports their persistence in STEM pathways, and facilitates their adaptation to rapidly changing vocational demands. For teachers, self-efficacy shapes their willingness to adopt innovative pedagogies and integrate STEM content effectively. In light of these findings, the following sections address the two guiding research questions of this review in greater depth.

4.1 Research Questions 1: Which Dimensions of Self-Efficacy Have Been Examined in the Setting of STEM oriented TVET?

This review systematically organizes and synthesizes the pertinent research on self-efficacy within the STEM-oriented TVET domain. The dimensions of self-efficacy examined in the studies were notably varied. Most of the studies were based on Bandura's social cognition theory (SCT), but there were some differences in how they were used and put into practice. Self-efficacy mainly includes three areas: academic orientation, task orientation, and career

orientation.

4.1.1 Theoretical Anchors and Divergence in Self-Efficacy Research within STEM-Oriented TVET

Bandura's Social Cognitive Theory (SCT) is still the most widely used theoretical framework in STEM-oriented TVET research. It gives a strong explanation of how self-beliefs affect learning and performance. For example, research on academic self-efficacy, like students' confidence in their ability to do math or science, often uses SCT as a framework (Arthur et al., 2025; Sevilla et al., 2023). Simultaneously, SCT has been modified into more specialized frameworks. Studies on task-specific technological self-efficacy, which look at how well students can use tools like augmented reality (AR) or computer-aided design (CAD), often use context-sensitive interpretations of SCT (Sirakaya et al., 2018; Hong et al., 2019). In a similar way, the Social Cognitive Career Theory (SCCT) builds on SCT to look at career-directed self-efficacy, which is how students think they can follow STEM paths (Sublett et al., 2018). While these variations signify theoretical innovation, they also reveal a deficiency in coherence, as studies often investigate academic, technological, and career dimensions in isolation. This fragmentation shows that future work needs to better connect theory and practice.

4.1.2 Academic-Oriented Self-Efficacy

Academic-oriented self-efficacy is when students believe they can learn and use disciplinary knowledge, especially in STEM fields like math, physics, and engineering. In STEM-oriented TVET environments, it is exhibited not only as confidence in managing intricate subject matter but also as perseverance in surmounting obstacles, the capacity to apply knowledge across diverse contexts, and perceptions influenced by social and situational factors. For example, Arthur et al. (2025) defined the idea of technology self-efficacy (TSE) for teachers using Bandura's three-part framework of level, strength, and generality. They showed how being confident in using digital tools makes teaching more effective. Conversely, Sevilla et al. (2023) elucidated that female students' academic self-efficacy in STEM vocational programs was influenced by gender norms and social comparison, with their confidence frequently limited by stereotypes. These findings suggest that academic self-efficacy is integral not only to students' academic success but also to maintaining motivation, developing professional identity, and advancing equity in vocational STEM pathways.

4.1.3 Task-Specific Technological Self-Efficacy

Task-specific technological self-efficacy measures how confident learners are in doing specific technological tasks, which is very important in STEM-oriented TVET education. Sirakaya and Kilic Cakmak (2018) demonstrated that the integration of augmented reality (AR) into vocational training correlated students' confidence with their proficiency in interpreting technical issues, devising solutions in simulations, and executing task-oriented assignments. They identified three components: confidence in integrating and applying new technical knowledge, assurance in performing AR-related tasks, and positive engagement with digital educational resources. Hong et al. (2019) also studied fashion design programs

that included STEM subjects such as CAD, materials engineering, and mathematical modelling. They discovered that students' creative confidence was significantly influenced by their proficiency with technology. These studies collectively underscore that proficiency in employing simulations, digital tools, and technology-mediated practices serves as a fundamental mechanism connecting technical learning to professional advancement.

4.1.4 Career-Directed Self-Efficacy

Career-directed self-efficacy focusses on students' belief in their ability to pursue and excel in STEM-related career paths. Sublett and Plasman (2018) delineated three dimensions of this construct among high school students enrolled in CTE programs: confidence in mastering academic STEM disciplines, confidence in applied technical proficiency, and confidence in pursuing further education or STEM employment. Their research indicated that increased engagement in applied STEM courses enhanced self-efficacy, subsequently bolstering STEM identity and career ambitions. Beyond coursework, career-oriented self-efficacy also encompasses decision-making skills such as accurate self-assessment, career information gathering, goal setting, planning, and problem-solving. Other studies have found that math and science self-efficacy strongly predict students' career decision-making efficacy and their STEM-related goals (Austin, 2010). These findings support the SCCT perspective that performance experiences and contextual learning are critical in shaping career-related self-beliefs, positioning self-efficacy as a bridge between educational experiences and long-term professional trajectories.

4.2 Research Questions 2: How does Self-Efficacy Impact Learning Outcomes and Teaching in STEM-oriented TVET Contexts?

Self-efficacy has consistently emerged as a central determinant of both learning and teaching outcomes in STEM-oriented TVET settings. Rather than functioning merely as a psychological disposition, it acts as a powerful predictor that directly links learners' academic progress, persistence, and career aspirations with teachers' instructional readiness and pedagogical innovation. High levels of self-efficacy among students are associated with stronger academic engagement, resilience in the face of difficulties, enhanced STEM identity, and greater perceived preparedness for future careers. For teachers, self-efficacy underpins the willingness to adopt new methods, integrate interdisciplinary content, and foster environments conducive to student success. The following subsections illustrate these impacts across academic learning, career development, social contexts, practice-based learning, and teaching practice.

4.2.1 Academic Learning and Skills Development

Within STEM-oriented TVET, self-efficacy significantly shapes students' mastery of academic content and technical skills. Studies show that while the use of augmented reality (AR) tools can improve efficiency in learning computer hardware, it does not necessarily enhance students' self-efficacy in hardware assembly (Sirakaya & Kilic Cakmak, 2018). Conversely, embedding the history of mathematics into instruction has been shown to boost mathematics self-efficacy, which subsequently increases learners' motivation and interest

(Arthur et al., 2025). Project-based and applied STEM courses further demonstrate the positive role of self-efficacy, though their effects vary by gender and learner groups: male students and general populations report stronger gains, whereas female learners and those with learning disabilities experience more modest improvements (Sublett & Plasman, 2018; Chandler et al., 2014).

4.2.2 Career Decision-Making and Identity Formation

Self-efficacy also plays a central role in shaping students' career decisions and identity development in STEM fields. For example, math/science self-efficacy was identified as the strongest predictor of African American high school students' career decision self-efficacy and STEM-related goal intentions (Austin, 2010). Participation in computer science CTE courses significantly enhanced students' STEM self-efficacy and identity, including among students with special learning disabilities (Plasman et al., 2022). Moreover, in STEM and design-related TVET programs, both interest and self-efficacy influenced vocational aspirations, but self-efficacy was found to be a much stronger predictor than interest, with significant gender differences indicating lower self-efficacy among female students (Güdel et al., 2019).

4.2.3 Gender and Social Contexts

Gender stereotypes and experiences of discrimination frequently diminish female students' confidence in pursuing STEM pathways. Sevilla et al. (2022) indicated that contextual barriers limit female students' self-efficacy in STEM careers. Even when they are in STEM-TVET programs, male students tend to get more out of teacher support and specialization than female students, whose gains in effectiveness are not as great (Sevilla & Rangel, 2023). These findings emphasise that self-efficacy is not solely an individual trait but also a socially constructed phenomenon shaped by institutional, cultural, and industrial contexts.

4.2.4 Practice-Based Learning and School-to-Work Transition

Self-efficacy also plays a mediating role in experiential learning contexts. A study of preservice teachers revealed fluctuations in their self-efficacy during practicum, influenced by feedback, workload, and assessment pressures, with reduced efficacy correlating to subpar teaching performance (Whitley et al., 2019). On the other hand, work-based learning experiences significantly enhanced students' confidence in their learning abilities and employability skills in STEM, with self-efficacy acting as the mediator that facilitated smoother transitions from school to work (Chukwuedo et al., 2023).

4.2.5 Teacher Readiness and Instructional Innovation

The quality of instruction is directly influenced by teacher self-efficacy. Endot and Jamaluddin (2023) showed that the readiness of TVET teachers to use Reasoning-Based Teaching (RBT) was greatly influenced by their beliefs in their own effectiveness and their own motivation. Teachers with higher self-efficacy exhibited greater confidence in employing reasoning-focused methodologies, which are essential for facilitating students'

problem-solving skills and critical thinking. These findings emphasise the imperative of incorporating self-efficacy enhancement into teacher training programs through techniques such as guided practice, collaborative engagement, and constructive criticism.

4.2.6 Cross-Disciplinary STEM Integration

Teachers' self-efficacy is relevant in interdisciplinary settings. Morgan et al. (2011) discovered that educators utilising the Math-in-CTE Model appreciated collaboration and were confident in their ability to integrate mathematics into vocational curricula. But institutional issues like not having enough time to get ready, language that wasn't always clear, and not having enough access to technology made it hard to carry out the plan. This indicates that while teacher self-efficacy is a prerequisite for innovation, it must be complemented by systemic and organizational support to ensure sustainable cross-disciplinary integration.

5. Limitations

This systematic review offers significant insights into the role of self-efficacy in STEM-focused Technical and Vocational Education and Training (TVET); however, it is essential to recognize several limitations. First, the evidence base is not very strong. Only fifteen empirical studies were included, which limits the generalizability of the findings and diminishes the capacity to substantiate broader claims regarding educational psychology. Second, research is not evenly spread out across the world. While contributions from countries like the United States, Chile, China, Nigeria, Switzerland, and Malaysia were noted, many areas, especially developing economies where TVET is important for preparing workers, are still not well represented. Third, there is a lack of methodological diversity. Most studies use quantitative designs, while qualitative and mixed-method approaches are much less common. This makes it harder to look more closely at the dynamic and context-sensitive processes that lead to self-efficacy. Fourth, the studies included span a broad range of disciplines, educational levels, and institutional contexts. This diversity improves the field but makes it harder to make consistent comparisons or figure out how studies are related to each other. Lastly, one should consider the possibility of bias in publication. Peer-reviewed journals frequently prefer studies with significant or positive outcomes, which may inflate the perceived impact of self-efficacy, a concern intensified by the absence of unpublished or null-result studies.

6. Implication

The results of this review have important effects on theory, practice, and policy. The findings validate Bandura's Social Cognitive Theory (SCT) as a principal framework for self-efficacy research, while also underscoring the imperative for enhancement to more precisely capture situational, gender-specific, and practice-oriented influences in STEM-oriented TVET. Evidence emphasises the imperative of explicitly addressing both teacher and student self-efficacy within TVET systems, particularly in contexts shaped by gender disparities and social inequities. Teacher training should not only teach them how to teach, but also how to systematically improve their self-efficacy through structured peer collaboration, formative feedback mechanisms, and practice-based simulations that help them feel more confident and

strong when things get tough in the classroom. For students, instructional interventions should integrate academic, task-specific, and career-oriented self-efficacy to foster not only academic achievement but also the cultivation of professional identity and long-term career readiness. Lastly, institutional barriers need to be dealt with so that teachers' self-efficacy can be turned into long-term teaching effectiveness. Some of these problems are not enough time for interdisciplinary collaboration, different words used in different fields, and not enough access to technology.

7. Recommendations

Based on the findings of this review, several recommendations can be drawn for future research and practice. First, to accurately depict the evolving nature of self-efficacy in STEM-oriented TVET, subsequent research should employ a broader range of methodological strategies, particularly prioritising mixed-methods and longitudinal frameworks. Second, in order to build a more globally representative body of knowledge, research should expand to underexplored regions such as Africa, Southeast Asia, and the Middle East, where TVET plays a vital role in workforce development. Third, intervention studies remain limited, and future work should design, implement, and validate specific practices aimed at enhancing teacher and student self-efficacy, including multidisciplinary integrated teaching, digital simulations, and project-based learning. Fourth, equity issues require more systematic attention. Future studies should examine how gender, socioeconomic background, and learning disparities influence the development of self-efficacy, while avoiding interventions that risk reinforcing existing inequalities. Finally, closer collaboration among policymakers, educators, and industry stakeholders is needed to create supportive environments that integrate academic preparation, technical training, and career guidance. Such collaboration will be essential for aligning STEM-TVET learning with labor market demands and ensuring that both students and teachers are equipped with the confidence and capacity to thrive.

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