

A Systematic Literature Review of Automotive TVET Teachers' Attitudes towards the Adoption and Implementation of Constructivist Teaching Modules for Automotive Air Conditioning Training.

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ABSTRACT

Traditional, teacher-centred, behaviourist teaching methods still predominate in TVET institutions today, particularly in technical subjects like HVAC and air conditioning. These methods frequently fail to foster in students a deeper comprehension, higher-order thinking, and practical competence. This study presents a systematic literature review of automotive TVET teachers' attitudes toward the adoption and implementation of constructivist teaching modules for automotive air conditioning (AAC) training. The review synthesises empirical evidence on teachers' attitudes, factors influencing adoption, implementation barriers, and the impact of constructivist instructional approaches on teaching effectiveness and skill acquisition in TVET contexts. A PRISMA-guided systematic review approach was employed, with literature retrieved from databases including Scopus, Web of Science, ERIC, ScienceDirect, SpringerLink, and Google Scholar. From an initial 6,871 records, 22 studies met the inclusion criteria after systematic screening, eligibility assessment, and quality appraisal. Thematic synthesis of the included studies revealed key patterns related to teacher attitudes, adoption determinants, and implementation challenges. Findings indicate that TVET teachers generally hold positive attitudes toward constructivist teaching modules; however, their adoption is influenced by professional development, instructional resources, self-efficacy, and institutional support. Major barriers include inadequate infrastructure, weak assessment systems, limited ICT integration, and insufficient industry collaboration. The review also shows that constructivist approaches, particularly project-based and learner-centred strategies, enhance learner engagement, critical thinking, and skill acquisition. Although there are several benefits, research specifically addressing automotive air conditioning training is limited, revealing a significant gap in the current literature. The study concludes that while constructivist teaching modules have strong potential to improve automotive TVET outcomes, their successful implementation requires improvements in teacher training, infrastructure, assessment practices, and curriculum industry alignment. The review provides a foundation for future development and evaluation.

Keywords: Systematic literature review; TVET, constructivist teaching modules; automotive air conditioning; teacher attitudes; PRISMA.

INTRODUCTION

Technical and Vocational Education and Training (TVET) constitute a strategic educational pathway for equipping learners with the competencies and occupational skills required in the global labour market. In many economies, TVET plays a pivotal role in workforce development, economic growth, and industrial transformation by equipping students with practical, job-ready skills (TVET institutions globally; see TVET conceptual frameworks). In the automotive technology discipline, the accelerated advancement of vehicle systems, including engine management, diagnostics, and climate control systems, has heightened demand for technically proficient graduates capable of performing complex servicing tasks such as automotive air conditioning (AAC) diagnosis, refrigerant management, and system repair. Automotive air conditioning training, as a specialised segment of TVET automotive programmes, encompasses both theoretical foundations (thermodynamics and refrigerant physics) and practical workshop competencies (pressure testing, evacuation,

charging, and fault diagnosis). However, numerous studies highlight persistent challenges in translating theoretical knowledge into workplace-relevant practical competence among learners. (Jalinus & Syaifullah, 2025). Despite TVET's mandate to produce industry-ready graduates, teaching practices in many institutions remain predominantly teacher-centred, with passive knowledge transmission limiting students' active engagement and constraining hands-on learning opportunities. Constructivist learning theory, grounded in cognitive and social constructivism, argues that learning occurs as learners actively construct meaning through experience, reflection, and social interaction rather than through passive reception of information. (Zou et al., 2025). This philosophy strengthens the alignment between learning activities and real-world tasks and has been shown to enhance conceptual understanding and skill acquisition in educational contexts where practical application is critical. Research on constructivist instructional approaches indicates that constructivist learning environments support students' active engagement, problem-solving, and reflection, all of which are essential for technical skill mastery. (Almulla, 2023; Tsehay et al., 2024; Mir et al., 2025)

In vocational education contexts, constructivist teaching methods have been associated with improved learner outcomes, including increased practical competence, deeper conceptual understanding, and higher retention of skills compared with traditional lecture-based methods. For instance, experimental research within mechanical and auto mechanics programmes has shown that student-centred, activity-based instructional strategies yield superior skill performance and cognitive gains relative to a conventional instructional approach (Mustapha et al., 2024). Similarly, studies in related TVET fields such as general machinery, welding, and HVAC suggest that active and enquiry-oriented pedagogies facilitate learners' ability to transfer classroom knowledge to workshop practice. (Daodu, et al., 2024 ; Tee et al., 2020; Tee Tze Kiong et al. 2026; Oluwadunmininu et al., 2025) Yet, despite the theoretical and empirical support for constructivist approaches, adoption and implementation in TVET, especially in AAC and related mechanical training, is uneven (Oluwadunmininu et al., 2025). Teachers' beliefs, attitudes, professional knowledge, and classroom practices significantly influence instructional choices and pedagogical innovation. Research in general education shows that teachers' attitudes toward constructivist teaching often determine their willingness to adopt and sustain learner-centred methodologies, with positive beliefs linked to greater implementation fidelity and student engagement on teacher beliefs and constructivist adoption (Choudhary, 2025; Tee et al., 2020; Tze et al., 2026). However, in vocational and technical contexts, instructors may face unique challenges that constrain adoption, such as inadequate workshop facilities, limited access to instructional resources, heavy teaching loads, and a lack of targeted professional development in constructivist pedagogy.

In many TVET institutions, particularly in developing countries, these barriers hinder teachers' capacity to transition from traditional teacher-centred methods to constructivist instructional practices that integrate theory with real-world tasks. (Choudhary, 2025). The intricate relationship between institutional resources, teacher preparedness, and instructional culture highlights the necessity for a comprehensive review of evidence regarding teachers' perceptions of adopting constructivist modules in technical areas like automotive air conditioning. Given this context, a systematic literature review focusing specifically on automotive TVET teachers' attitudes toward adopting and implementing constructivist teaching modules in automotive air conditioning (AAC) training is warranted. (Adelowo et al., 2024). Such a review will consolidate evidence on how teachers perceive constructivist innovations, identify major facilitating or impeding factors, and provide insights necessary for designing professional development, curriculum improvements, and policy initiatives aimed at enhancing AAC pedagogical practice in TVET.

Statement of the problem

Automotive air conditioning (AAC) practical training in Nigerian TVET institutions is still largely delivered through ineffective, teacher-centred methods that limit students' active skill development. As a result, many TVET graduates demonstrate poor competency outcomes and struggle to meet workplace expectations in AAC installation, servicing, and troubleshooting. Although constructivist teaching approaches have been identified as effective for improving practical skills acquisition, their adoption in AAC instruction remains limited. A major factor influencing the implementation of such innovative modules is teachers' attitudes, which may either hinder or support effective instructional change. Therefore, this study addresses the need to examine how teachers' attitudes affect the adoption of constructivist teaching modules for improving automotive air conditioning (AAC) practical training and graduate competence.

Aim and Objectives of the Study

To systematically review empirical literature on automotive TVET teachers' attitudes toward the adoption and implementation of constructivist teaching modules for automotive air conditioning training.

1.4 Objectives:

1. To identify the nature of teachers' attitudes toward constructivist teaching modules in automotive TVET.
2. To examine factors influencing the adoption and implementation of constructivist modules in AAC training.
3. To explore reported challenges and barriers teachers face during implementation.
4. To identify strategies recommended in the literature for improving adoption and implementation.
5. To synthesise evidence on how constructivist module adoption affects teaching effectiveness and skill acquisition.

Research questions guided the study

1. What attitudes do automotive TVET teachers hold toward constructivist teaching modules for AAC training?
2. What factors influence their willingness to adopt constructivist modules?
3. What barriers hinder implementation in AAC practical training?
4. What strategies have been suggested to support successful adoption and implementation?
5. How does the adoption of a constructivist module affect teaching effectiveness and skill acquisition?

Significance of the study

This study is significant because it focuses specifically on automotive TVET teachers and examines how constructivist teaching modules can improve instructional practices in automotive air-conditioning training. It also provides empirical evidence to guide effective curriculum improvement and skills development in automotive TVET programmes.

The purpose of the study

The purpose of the study and the literature gap is to address what previous studies have failed to address, particularly in AAC TVET and in the adoption of constructivist modules. Additionally, the objectives and questions are justified because they directly respond to the identified problem and the lack of evidence in the literature.

LITERATURE REVIEW

2.1 To address this gap, the present study conducts a systematic literature review (SLR) of empirical research published between 2018 and 2025, focusing on the attitude of TVET teachers on the adoption and implementation of a constructivist module. The review follows the PRISMA protocol and synthesises findings from 22 peer-reviewed studies, aiming to clarify the strategies, theoretical frameworks, technological implementations, and learning outcomes associated with the constructivist teaching module in TVET. The five research questions guide the review.

METHODOLOGY

Research Design

The review also included broader TVET, HVAC, refrigeration, and constructivist instructional studies that provided pertinent pedagogical and contextual insights applicable to AAC instruction, as few empirical studies were specifically focused on automotive air conditioning (AAC) training. However, to preserve contextual relevance, AAC-specific studies were prioritised during synthesis where available. A Systematic Literature Review (SLR) is a rigorous and transparent research design that systematically identifies, evaluates, and synthesises all relevant empirical studies on a specific research topic using predefined protocols. This study adopted an SLR to identify, evaluate, and synthesise existing empirical studies on automotive TVET teachers'

attitudes towards the adoption and implementation of constructivist teaching modules for automotive air conditioning training. The SLR approach was selected because it provides a transparent, replicable, and evidence-based method for synthesising research findings across multiple studies using predefined protocols. Unlike traditional narrative reviews, the SLR minimises bias through structured search and selection procedures and ensures comprehensive coverage of relevant literature.

The adoption of the SLR methodology is justified by its capacity to produce comprehensive, reliable, and evidence-based findings. First, SLR enhances transparency and replicability by following a clearly defined protocol, often guided by frameworks such as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which ensures that each stage of the review process is systematically documented (Matthew et al., 2021). Second, it minimises selection bias by applying explicit inclusion and exclusion criteria, thereby ensuring that only relevant and high-quality studies are included in the synthesis. This is particularly important in educational research, where studies may vary widely in methodology and context. Third, SLR is appropriate for this study because the topic of teachers' attitudes towards constructivist teaching in TVET spans diverse geographical and educational contexts, necessitating systematic integration of findings to identify patterns, contradictions, and research gaps.

Finally, SLR provides strong empirical grounding for decision-making in educational practice and policy development. By synthesising evidence across multiple studies, it offers a more robust understanding of how constructivist teaching modules are perceived and implemented in automotive TVET settings, thereby informing curriculum development and teacher professional development initiatives Gough, Oliver & Thomas, 2017 in (Shi & Bangpan, 2022)

Review Protocol and Reporting Framework

The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. (Matthew et al., 2021). The PRISMA framework guided the processes of study identification, screening, eligibility assessment, and final inclusion to ensure methodological transparency and replicability. The framework also provided a structured audit trail demonstrating how the final frame of evidence was selected and synthesised.

Data Source and Database Search

A comprehensive database search was conducted to identify relevant literature on constructivist teaching modules, TVET instruction, teacher attitudes, and automotive air conditioning training. The search drew on major academic databases known for strong indexing of vocational education, engineering education, and instructional design studies. The literature search was conducted across six major academic databases: Scopus (6 articles), Web of Science (3 articles), ScienceDirect/Elsevier (4 articles), ERIC (1 article), SpringerLink (2 articles), and Google Scholar (6 articles), resulting in a total of 22 included studies. These databases were selected for their extensive coverage of peer-reviewed journal articles and conference proceedings related to educational research, TVET, constructivist pedagogy, and technical skill development. The distribution of retrieved studies across databases is presented to enhance methodological transparency and demonstrate the breadth of the literature search process.

Search Strategy and keywords

A systematic search strategy was developed using a combination of keywords and Boolean operators (AND, OR) to ensure comprehensive retrieval of relevant studies. The search terms were derived from the core concepts of the study variations and their synonyms, such as: "TVET" OR "vocational education" AND "automotive training" OR "automotive education" OR "air conditioning" OR "automotive air conditioning" AND "constructivist teaching module" OR "instructional module" AND "teacher attitude" OR "teachers' perception". These keywords were combined in multiple ways to ensure a broad yet relevant search outcome. The search was limited to peer-reviewed journal articles and conference papers published in English between 2018 and 2025, resulting in an initial pool of 6,871 records, as depicted in Fig. 1, which outlines the identification and selection process following the PRISMA 2020 framework. (Matthew et al., 2021). Figure 1 illustrates the PRISMA flow diagram for the selection of studies on the constructivist teaching module.

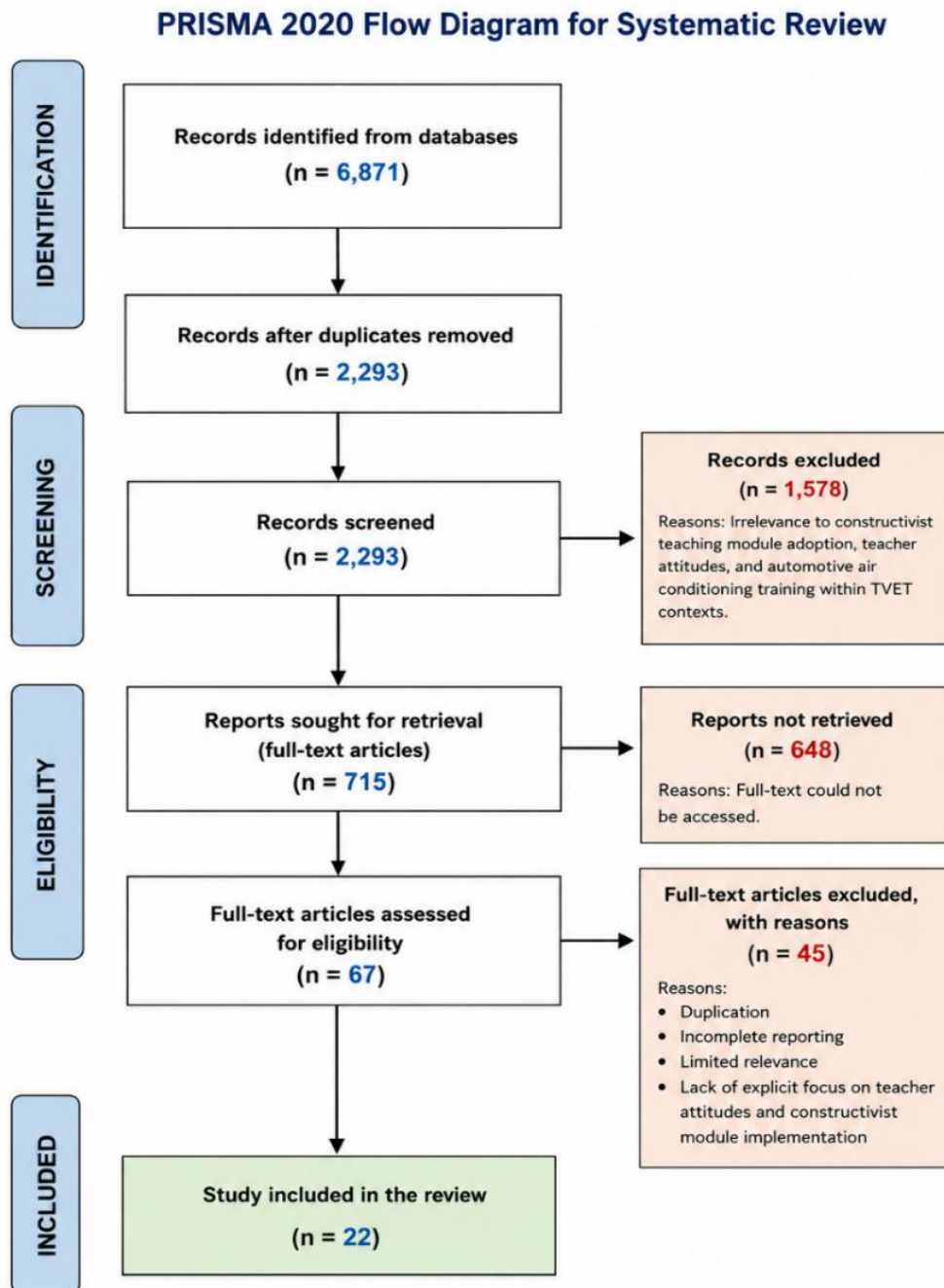


Figure 1. PRISMA 2020 Flow diagram for systematic Review.

Screening and Eligibility (PRISMA Selection Process)

The study selection process followed the PRISMA 2020 flow structure of identification, screening, eligibility, and inclusion (Matthew et al., 2021). The initial database search yielded (n = 6,871) records. Following duplicate removal, 2,293 unique records remained for title and abstract screening. During the screening stage, 1,578 records were excluded because they were not directly relevant to constructivist teaching module adoption, teacher attitudes, AAC training, or TVET contexts. Studies focusing exclusively on general education, unrelated technical disciplines, or student perspectives without teacher-related evidence were also excluded. Subsequently, 715 reports were sought for retrieval; however, 648 reports could not be accessed due to database restrictions or incomplete availability. Consequently, 67 full-text articles progressed to the eligibility assessment stage. The full-text review resulted in the exclusion of 45 studies due to duplication, incomplete reporting, limited methodological clarity, insufficient relevance to the review objectives, or lack of explicit focus on constructivist module implementation and teacher attitudes. Ultimately, 22 studies satisfied all inclusion criteria and were retained for final synthesis. A PRISMA flow diagram in Figure 1 was used to illustrate the complete screening and eligibility process.

Inclusion Criteria and Exclusion Criteria

To ensure that only relevant and credible evidence was included, this review applied clear inclusion and exclusion criteria before screening. The review included only English-language empirical studies published in peer-reviewed journals or credible conference proceedings that focused on TVET/vocational/technical education. The eligible studies specifically examined constructivist or learner-centred teaching modules and reported evidence on teachers' attitudes, perceptions, readiness, or experiences regarding their adoption and implementation. Finally, only empirical studies (qualitative, quantitative, or mixed-method) were included to ensure that conclusions were based on real data and evidence rather than opinion or purely theoretical discussions. Studies were excluded if they were not related to TVET or vocational education, focused only on students without teachers' perspectives, were purely conceptual without empirical data, or were non-peer-reviewed sources such as editorials, dissertations, or opinion papers. Articles not relevant to automotive training or constructivist module adoption and implementation were also excluded.

Table 1: Inclusion and exclusion criteria

Criteria	Inclusion Criteria	Exclusion Criteria
Publication Type	Peer-reviewed journal articles	Editorials, opinion papers, conference abstracts/proceedings, book chapters, dissertations/theses
Timeframe	Studies published between 2018 and 2025	Publish before 2018 or after 2025
Language	Studies published in English	Studies published in languages other than English
Study design /methodology	Empirical studies using quantitative, qualitative, or mixed methods (e.g., quasi-experimental, pretest-post-test, surveys, case studies, R&D, evaluation research)	Studies without a clear research design or method; purely conceptual/theoretical papers without empirical data
Context / Setting	Studies conducted in Technical and Vocational Education and Training (TVET), vocational colleges, technical colleges, polytechnics, or related skills training institutions	Studies conducted outside TVET or not related to vocational skills training
Subject Focus	Studies focusing on air conditioning, refrigeration, automotive air conditioning, HVAC training, or cooling systems training	Studies not related to air conditioning, refrigeration, or HVAC training.
Intervention / Instructional Approach	Studies involving constructivist-based instructional modules, constructivist teaching strategies, problem-based learning, inquiry learning, collaborative learning, or learner-centred modules applied to HVAC/AC training	Studies not based on constructivist teaching principles or not involving instructional modules/teaching interventions.
Population	Studies involving TVET teachers, instructors, trainees, or students in air conditioning/HVAC-related programmes	Studies involving unrelated populations (e.g., general education without vocational focus)
Outcomes / Evidence	Studies reporting outcomes such as skill acquisition, learning performance, competency development, teacher attitudes, learner engagement, implementation effectiveness, or module evaluation results	Studies without measurable outcomes or insufficient evidence for analysis
Data Quality / Rigour	Studies with clear objectives, detailed methodology, and sufficient data for synthesis	Studies with unclear objectives, incomplete methods, or inadequate results reporting

Table 1 presents the inclusion and exclusion criteria used to determine which studies were eligible for selection in the systematic review. The criteria were designed to ensure that only studies relevant to TVET-based air conditioning training and the use of constructivist instructional modules were included. Peer-reviewed journal articles published between 2018 and 2025 and written in English were considered. Eligible studies were required

to use empirical research designs, such as quasi-experimental, survey, case study, or research-and-development approaches. Studies were excluded if they lacked a clear methodology, were unrelated to TVET or air conditioning training, or did not provide sufficient outcome data for analysis. This process ensured that only methodologically sound and relevant studies were synthesised.

Quality Appraisal of Included Studies

To ensure methodological rigour and reliability, all included studies underwent quality appraisal before synthesis. The appraisal process was guided by adapted principles from the Critical Appraisal Skills Programme (CASP) and Joanna Briggs Institute (JBI) frameworks commonly applied in educational systematic reviews. Each study was evaluated based on: Clarity of research objectives, Appropriateness of research design, Sampling adequacy, Data collection procedures, Analytical transparency, Validity and reliability of findings and Relevance to AAC and TVET contexts. Studies were categorised as high, moderate, or low quality based on cumulative assessment outcomes. Only studies rated as moderate or high quality were included in the final synthesis to strengthen the credibility of the review findings and reduce methodological bias. To enhance reliability, the screening, coding, and appraisal processes followed predefined review procedures and repeated cross-checking of extracted evidence.

Data Extraction Procedure

Data extraction was carried out systematically using a structured extraction template to ensure consistency across all included studies. For each article, relevant information was recorded, including authors and year of publication, country and study context, research design, participants, type of constructivist instructional approach, key findings on teachers' attitudes, factors influencing adoption, barriers to implementation, and authors' recommendations. This structured process facilitated the organisation of evidence into comparable categories, thereby supporting a coherent and systematic synthesis of findings across the studies.

Data Synthesis and Thematic Analysis

After carefully applying our inclusion and exclusion criteria, we narrowed it down to an exciting collection of 22 studies that we will synthesise for our final analysis. Due to the methodological diversity of the included studies, which comprised quasi-experimental designs, surveys, research and development (R&D) studies, case studies, and mixed-method approaches, a statistical meta-analysis was considered unsuitable. Consequently, a narrative thematic synthesis approach was adopted to enable the integration and interpretation of findings across diverse research contexts and methodologies. The extracted data were systematically analysed by identifying recurring patterns, concepts, and relationships within the selected studies. The studies were then organised into thematic categories aligned with the objectives and research questions of the review.

The synthesis focused on major areas of evidence, including teachers' attitudes toward constructivist teaching modules, factors influencing adoption such as teacher competence, motivation, institutional support, and professional readiness, barriers to implementation including inadequate facilities, limited instructional resources, insufficient training, and time constraints, as well as strategies for improving implementation through professional development, curriculum enhancement, industry collaboration, and provision of workshop facilities.

In addition, the thematic synthesis distinguished studies directly related to automotive air conditioning (AAC) training from broader TVET and constructivist instructional literature to improve contextual clarity and analytical depth. This process enabled comparisons across different educational settings while also identifying methodological differences, contextual limitations, and recurring implementation challenges. The findings were subsequently consolidated into themes and sub-themes to provide a coherent and structured interpretation of the literature.

Synthesis Considerations

This study did not involve direct human participation, as it relied solely on secondary data from published journal articles. Nevertheless, ethical research practice was maintained through proper citation of all sources and

adherence to academic integrity standards to avoid plagiarism and misrepresentation of evidence. After the screening and eligibility process, all included studies were subjected to final synthesis. The synthesis stage involved extracting relevant evidence from each selected article and organising the findings according to the objectives of the review. Specifically, key information such as author/year, study design, sample, intervention type (constructivist module or teaching strategy), implementation process, and reported outcomes were summarised. Thereafter, the extracted findings were compared across studies to identify similarities, differences, and recurring patterns in constructivist module adoption, teacher attitudes, and implementation challenges in TVET air conditioning training.

The synthesis was conducted using a narrative synthesis approach because the included studies adopted different methodologies (quasi-experimental, survey, R&D, case studies, and mixed methods), making statistical meta-analysis inappropriate. The evidence was therefore synthesised thematically, with studies grouped under common categories such as instructional design approaches, constructivist teaching strategies applied, learning outcomes, teacher perceptions, and barriers to implementation. Finally, the results were consolidated into themes and sub-themes to provide a structured interpretation of the literature and answer the review questions.

LIMITATIONS OF THE REVIEW

There are several limitations to this review. First, because many empirical studies do not specifically address training in automotive air conditioning, more general TVET and constructivist instructional studies had to be included, which could reduce contextual specificity. Second, direct comparability across studies was hampered by differences in participant characteristics, educational environments, and study design. Third, even when systematic appraisal and thematic analysis techniques are used, the narrative synthesis approach may require interpretive subjectivity. Lastly, the inclusion of only English-language research may have excluded potentially pertinent data published in other languages.

RESULTS AND DISCUSSION

Teachers and Teaching Instructional Materials

This section presents a synthesis of 22 studies published between 2018 and 2025 examining teachers' attitudes toward the adoption and implementation of constructivist teaching modules within TVET and related educational contexts. Although only a limited number of the reviewed studies directly focused on Automotive Air Conditioning (AAC) instruction, the broader TVET and constructivist literature provides important pedagogical insights relevant to technical and vocational education. The findings consistently emphasise the interconnected roles of teacher development, instructional materials, pedagogical competence, assessment practices, technology integration, and industry collaboration in improving teaching effectiveness and learner outcomes. Across the reviewed studies, instructional materials were widely recognised as essential tools for supporting learner-centred teaching and practical competency development. However, differences emerged regarding the types of instructional resources used and the contexts in which they were implemented. Umam et al. (2019) demonstrated that constructivist-oriented training improved teachers' facilitation skills and instructional effectiveness, particularly in promoting active learning environments. Similarly, Setiyani et al. (2020) reported that digital instructional materials enhanced learner communication and independence in mathematics education, while Shaifuddin and Nashir (2022) found that technical instructors preferred electronic instructional materials in electrical and electronic education because they improved comprehension and learner engagement.

Although these studies were conducted in different disciplinary contexts, they collectively suggest that well-designed instructional materials can positively influence teaching delivery and student participation across vocational education settings. Nevertheless, important contextual differences remain evident. Most of the reviewed studies focused on general education, mathematics, or technical subjects outside AAC training, indicating that direct empirical evidence regarding constructivist instructional materials specifically for automotive air conditioning remains limited. This suggests that while broader TVET findings may provide conceptual support for AAC instruction, caution is required when generalising their effectiveness to highly technical refrigeration and automotive workshop environments. The review revealed that assessment practices pose an ongoing challenge in implementing constructivist teaching. According to Atukunda and Maja (2022),

lecturers faced difficulties in completing instructional content because of inadequate assessment tools and limited instructional time. Similarly, Tee et al. also noted similar challenges. (2020) found that although teachers valued problem-solving and creative thinking, many lacked the pedagogical competence required to integrate these skills effectively into classroom practice. These findings indicate that positive teacher attitudes toward constructivist approaches do not automatically translate into successful implementation. Instead, effective adoption depends on the availability of adaptable instructional materials, competency-based assessment strategies, and continuous pedagogical support.

This issue is particularly relevant to the Nigerian TVET context, where industry-aligned assessment and practical competence are critical for preparing graduates for workplace demands. Compared to general education settings, AAC instruction requires more specialised workshop-based assessment approaches involving refrigeration diagnostics, troubleshooting, equipment handling, and practical demonstrations. However, the reviewed studies provided only limited discussion regarding how constructivist assessment strategies can be effectively adapted to AAC-specific learning environments. Teacher self-efficacy and professional identity also emerged as influential factors affecting instructional effectiveness. Song and Sabran (2023) observed that teachers' personal and professional experiences shaped their instructional confidence and teaching beliefs, while Baroudi and Shaya (2022) found that teaching experience was more strongly associated with online teaching efficacy than formal training alone. Comparatively, studies focusing on professional development consistently demonstrated that teachers with stronger pedagogical confidence were more willing to adopt learner-centred instructional approaches than those relying primarily on traditional lecture-based methods.

These findings collectively suggest that instructional innovation cannot rely solely on the provision of teaching materials or technology. Rather, successful implementation requires simultaneous investment in teacher confidence, reflective practice, and continuous professional development. This observation is particularly important within AAC training environments, where instructors must combine pedagogical competence with specialised technical expertise in refrigeration and automotive systems.

Technology integration emerged as another dominant theme across the reviewed literature, although implementation outcomes varied considerably depending on institutional context and resource availability. Chukwutem Onwusa (2021) and Katcha Muhammed (2022) revealed that while Nigerian teachers acknowledged the value of Microsoft tools and digital instructional technologies for science teaching, public institutions faced greater infrastructural and technological limitations compared to private schools. Similarly, Song and Sabran (2023) found that digital support improved online teaching satisfaction among instructors but did not necessarily enhance instructional creativity or innovation. A comparison across these studies indicates that technology integration alone does not guarantee effective constructivist implementation. Rather, implementation effectiveness appears strongly influenced by infrastructural readiness, teacher training, internet accessibility, and institutional support systems. These contextual disparities are particularly significant within Nigerian TVET institutions, where inconsistent access to modern workshop technologies and digital resources may limit the successful implementation of technology-supported AAC instructional modules. Industry collaboration and vocational pedagogy were also identified as critical components of effective TVET instruction. Ariyo et al. (2020) reported that successful Industrial Field Experience (IFE) programmes depended heavily on strong collaboration between educational institutions and industry partners, although many institutions lacked effective post-training evaluation mechanisms. Similarly, Ismail et al. (2019) and Maksum and Purwanto (2022) found that entrepreneurship and vocational readiness programmes improved graduate employability when integrated consistently throughout the educational process. Cross-national comparisons by Yunos et al. (2020) further revealed that although Malaysian and Indonesian TVET teachers employed similar pedagogical approaches, significant contextual differences influenced implementation effectiveness. These findings suggest that constructivist teaching strategies cannot be universally applied without considering local institutional conditions, cultural context, industrial demands, and available resources. Overall, the reviewed studies demonstrate that instructional materials, teacher competence, professional development, technology integration, and industry collaboration are interrelated factors influencing the successful implementation of constructivist teaching approaches within TVET. However, the review also reveals several important limitations within the existing literature. First, most studies focused broadly on TVET, general technical education, or digital learning rather than AAC-specific instructional contexts. Second, methodological differences across studies limited the direct comparability of findings. Third, infrastructural limitations and unequal technological access continue to

constrain implementation effectiveness, particularly within developing-country TVET systems. Consequently, the present study addresses an important research gap by focusing specifically on the development of a constructivist teaching module for Automotive Air Conditioning within Nigerian TVET institutions. By integrating instructional design principles with constructivist pedagogy and industry-relevant competencies, the study seeks to provide a contextually appropriate instructional framework capable of addressing both theoretical concerns identified in the literature and practical challenges experienced within technical vocational training environments.

Table 1: Previous Studies on Teachers and Teaching Instructional Materials

Authors/ Years	Aims	Methodology	Findings	Limitation
Umam et al. (2019)	The purpose of this study is to demonstrate the value of constructivist training for enhancing self-help material teaching abilities in early childhood education.	Quasi-experimental Research	The ability of teachers to teach self-help material is enhanced through constructivist learning methods training.	The implication is that the research on teaching instructional materials can serve as a foundation for improving teachers' abilities to facilitate teaching and learning.
Atukunda and Maja (2022)	Examined the lecturers' experiences with internal continuous assessment (ICASS) in computer practice instructional materials.	Quantitative	The results showed that there was not enough time to finish the curriculum and that the assessment techniques were inadequate to meet the wide range of student needs.	Policymakers recommend that the TVET college administration improve facilities and equipment and offer specialised in-service training for lecturers' professional development.
Setiyani et al. (2020)	A study designed a digital module for mathematical communication skills,	Qualitative	communication skills, which were highly valid with a 95.1% expert validation and 89.8% student response, indicating their potential to enhance students' independence in learning	It is recommended that the efficacy of using digital instructional materials in the classroom be investigated
Katcha and Mohammed (2022)	This study focuses on how educators perceive their critical thinking and inventive problem-solving skills.	Quantitative	Science teachers in private schools make good use of Microsoft products, but in the Federal Capital Territory, these resources were not as readily available or as effectively used in public schools.	The study promotes greater Microsoft Tools application adoption by Nigerian schools.
Tee et al.(2020)	This study investigates how teachers see their way of thinking and creative problem-solving abilities.	Quantitative	Teachers acknowledge creative problem-solving and thinking styles, but only half believe they have mastered these skills. Identifying root causes is crucial for	A high-quality TVET graduate can improve students' outlook, and early exposure to TVET careers can benefit them. Design educators must support

			effective problem-solving.	students' physical, emotional, spiritual, and intellectual development.
Yunos et al. (2020)	This study was carried out to produce empirical proof of the variations in teaching and learning strategies utilised by engineering TVET teachers in Malaysia and Indonesia.	Quantitative	Research reveals similarities and differences in teaching strategies between Malaysian and Indonesian educators, emphasising the significance of vocational pedagogy for young Malaysians and Indonesians in TVET.	The limitations related to sampling bias. The sample of 183 teachers may not fully represent the entire population of engineering TVET teachers in Malaysia and Indonesia, potentially impacting the generalizability of the findings.
(Çibukçiu, 2025)	This study examines how constructivist approaches affect students' ability to solve mathematical problems, an important topic in current educational research.	Mixed method	These results imply that incorporating constructivist approaches into math instruction can be a useful tactic to raise students' problem-solving abilities. This study confirms that the use of constructivist methods in solving mathematical problems has a significant positive impact.	These findings suggest that the integration of constructivist methods in teaching mathematics can be an effective strategy to help improve students' performance in solving mathematical problems.
(Çibukçiu & Shaqiri, 2024)	This study aimed to examine the effect of using the constructivist approach on classroom academic performance among teachers with low self-efficacy.	Quantitative	The study findings indicate that teachers' self-efficacy has a strong and statistically significant relationship with class academic performance ($r = .729^{**}$, $p < .001$). In addition, the Wilcoxon signed-rank test revealed a significant difference in academic performance before the use of the constructivist approach ($M = 37.90$; $SD = 4.92$) and after its implementation ($M = 50.75$; $SD = 4.14$), with results showing $Z = -2.803$, $p = .005$	The study is limited by a small sample size (20 participants) and a short duration (one month), which restricts generalizability and prevents assessment of long-term effects. Future research should use larger samples, include more schools, and extend the study period for a more comprehensive and in-depth analysis.
Song and Sabran (2023)	This study investigated the connections between teaching efficacy, innovation, and satisfaction among Chinese university EFL	Quantitative	Online peer support did not significantly improve teacher creativity or satisfaction, but increased autonomy and help with teaching	To gather unbiased information about the connections between teaching efficacy, satisfaction, creativity, and support, future

	instructors when teaching online.		materials did improve university EFL teachers' online teaching satisfaction, according to the study.	research should employ a mixed-methods design and investigate additional avenues for understanding these connections.
(Aziz & Sahid, 2025).(Aziz & Sahid, 2025)	This study seeks to investigate how the project-based learning (PBL) approach, specifically active learning, self-directed learning, product-oriented learning, and critical thinking, affects students' academic performance in Business-related subjects.	Quantitative	The results indicate that students should remain dedicated to actively participating in the PBL approach adopted by their teachers. Likewise, teachers are advised to design effective and stimulating lessons that sustain students' interest and engagement.	Teachers are advised to design well-structured and engaging lessons that attract and maintain students' interest.
(Daodu et al., 2024)	The study investigates the function and traits of using constructivist theory as a teaching strategy.	Review	The advantages of applying the constructivist theory as a teaching strategy are clearly described. A few objections to applying this theory as a teaching strategy were addressed.	According to the study, using this approach effectively would undoubtedly improve students' ownership and comprehension of the material.
(Choudhary, 2025)(Choudhary, 2025)	The study examines how educators' attitudes toward learning, teaching, and knowledge construction affect their readiness to use constructivist, student-centred methods in teacher education programs.	Mixed method	According to the results, just 40% of teachers regularly use constructivist teaching methods, despite the fact that 67% of educators have favourable opinions about these ideas.	The study cites several major obstacles, such as resource limitations, instructional restrictions, and deeply rooted traditional teaching views.

Table 2: Previous study on Refrigeration and Air Conditioning

Authors/ Years	Aims	Methodology	findings	Limitation
Audu et al. (2022)	Investigate how automotive air conditioning system maintenance practices used by Nigerian service technicians in Niger State affected the environment.	Survey research designed	It is risky to breathe in concentrated refrigerant vapour, and exposure to fluorocarbon levels can cause drowsiness and a loss of focus. Because of ozone depletion, excessive UV exposure can cause skin cancer, skin irritation,	Waste from dangerous car air conditioning is produced by auto repair. Always have licensed individuals remove technicians' shops under environmental agency supervision.

			cataracts, and weakened immune systems.	
Ziblim et al. (2018)	This study evaluates roadside mechanics' abilities to identify and resolve issues with vehicle systems and parts in the Tamale Metropolis.	Qualitative	According to the study, Tamale Metropolis car technicians lack technical expertise and are unable to use computers, manufacturer's manuals, or contemporary diagnostic equipment.	It was suggested that the government should train roadside mechanics to improve their expertise in automobile electronics.
Akinola et al. (2020)	Enumerate the difficulties that TVET institutions and industry face when working together to acquire skills for sustainable growth in Nigeria.	Quantitative	The study found that the major challenges facing TVET institutions and industry in Nigeria are a lack of collaboration between institutions and industry, political instability, and poor funding, among others.	The study suggested that the TVET-industrial scholarship board be set up in each of Nigeria's six geopolitical zones.
Ogunode et al. (2022)	This essay looked at the challenges to funding public universities in Nigeria.	Review.	Nigerian universities face challenges like low internal revenue, corruption, national debt servicing, insecurity, subsidised payments, revenue leaks, lack of funding for policy execution, and declining national revenue.	The national strategy for funding education in Nigeria should be put into action by the federal, state, and local governments. The anti-corruption agency should combat corruption in all public universities.
Sutadji (2020)	Created a multimedia engine management system that is interactive in Saudi Arabia.	Mixed-method Saudi Arabia	The study discovered that the interactive multimedia engine management system developed was successful in enhancing the automotive industry's prior knowledge and problem-solving skills.	Potential confounding variables and control groups that might have impacted the validity of the results were not addressed in the study. Go to Auto.
Sarwandi et al.(2019)	This study aimed to develop and execute mobile-based e-instructional materials, gather student and instructor opinions, and evaluate students' learning outcomes after their use.	Research and Development research method.	The findings of this research indicate the successful design and implementation of mobile-based e-instructional materials for construction engineering education.	Future work could focus on continuous improvement of the e-instructional materials based on feedback received, ensuring adaptability to evolving educational needs and technological advancements.
Kpabep & Festus (2019)	The study created a module that vocational and technical education institutions can use to teach leak detection techniques in refrigeration and air conditioning.	Survey design	The study accepted fifty items and 26 steps for a leak detection module in refrigeration and air-conditioning, indicating that developing such instructional materials can enhance trainee training and skill mastery.	To stop the release of refrigerants that deplete the ozone layer, Vocational and Technical Education institutions and training centres are encouraged to implement a module on leak detection in air conditioning and refrigeration.
Wahab et al. (2020)	Examining the difficulties that	Qualitative	Highlights several difficulties that automotive technology	When it comes to giving precise and up-to-date

	automotive technology faces, considering recent advancements, is the primary goal of the research.		faces in the face of fresh advancements. Some of the challenges that face automotive technology educators are insufficient workshop training facilities, insufficient opportunities for training and retraining, and incompetent instructors.	information about the state of automotive technology in Kwara State, Nigeria, using secondary sources may present challenges. More quantitative data might be needed for a more thorough understanding.
Oluwatimilehin et al. (2021)	A study examined the perceptions of automobile industry workshop craftsmen and technical teachers regarding the integration of automobile mechatronics technology into the curriculum.	Survey	The study found that both automobile teachers and craftsmen were not aware of some automobile mechatronics sub-systems. The respondents were well knowledgeable in leading workplace communication,	The study was conducted in Enugu State, Nigeria, which may limit the generalizability of the findings to other regions or countries.

Previous Studies on Automotive Air Conditioning and Technical Training

Existing scholarship on automotive air conditioning (AAC) and related technical education has increasingly highlighted environmental, technical, pedagogical, and employability concerns within TVET systems. However, the reviewed literature demonstrates important variations in research focus, with most studies concentrating either on environmental and technical issues or on general vocational training practices rather than on the systematic development of constructivist instructional modules specifically for AAC training. A major theme identified across the reviewed studies relates to environmental safety and refrigerant management practices. Audu et al. (2022) and Jiya et al. (2022) emphasised the environmental and health risks associated with poor maintenance practices in Nigeria, particularly the unsafe handling of refrigerants, inhalation of refrigerant vapours, and improper waste disposal methods. These studies collectively highlight the growing need for environmentally responsible refrigeration practices and stricter regulation of refrigerant handling within automotive service operations. However, although the studies effectively identified environmental hazards, they provided limited discussion regarding how TVET institutions can pedagogically integrate environmental safety competencies into AAC training curricula. Consequently, the literature remains largely descriptive regarding environmental challenges while offering insufficient instructional guidance on skill-transfer mechanisms and constructivist training strategies.

In comparison, another group of studies focused more directly on technical competence and practical skill deficiencies among technicians and students. Ziblim et al. (2018) found that Ghanaian roadside mechanics lacked adequate competence in using diagnostic equipment, technical manuals, and modern servicing tools. Similar findings were reported within Nigerian contexts, where weak collaboration between TVET institutions and industry limited effective technical skill transfer (Akinola et al., 2020). Likewise, Nkwachi (2018) and Onyebuenyi et al. (2018) observed that students demonstrated insufficient practical competence in air conditioning installation, servicing, and maintenance procedures. Collectively, these studies consistently reveal a mismatch between theoretical instruction and workplace skill requirements. While the studies clearly identified deficiencies in hands-on competence, most focused primarily on reporting technical skill gaps rather than evaluating instructional methods capable of addressing those deficiencies. As a result, limited empirical attention has been given to how constructivist instructional approaches, practical learning activities, or competency-based modules may improve AAC training effectiveness within TVET institutions.

Another important issue emerging from the literature concerns curriculum relevance and labour market alignment. Okolie et al. (2019) reported that higher education institutions in Nigeria have attempted to revise curricula to improve graduate employability; however, effective alignment between institutional training and

industry expectations remains underdeveloped, particularly within technical disciplines such as automotive air conditioning. Ogunode et al. (2022) further highlighted that financial and structural challenges facing educational institutions continue to limit curriculum innovation, infrastructural development, and technical training. These findings indicate that curriculum reform alone may not be sufficient without corresponding institutional investment, industry collaboration, and instructional innovation. Compared to broader vocational disciplines, AAC training requires specialised workshop environments, refrigeration equipment, and practical diagnostic activities, which may be difficult to sustain in resource-constrained institutions. The reviewed studies indicate a clear need for cost-effective, industry-oriented, and competency-based instructional modules that can enhance both technical proficiency and employability outcomes. The role of technology and digital instructional innovation also emerged as a recurring theme within the literature. Studies conducted outside Nigeria generally reported more positive outcomes regarding the use of technology-supported instructional strategies. For example, Sutadji (2020) demonstrated that multimedia learning systems improved students' knowledge acquisition and problem-solving abilities in technical education contexts. Similarly, Sarwandi et al. (2019) found that mobile-based electronic instructional materials enhanced student engagement and learning participation.

These studies suggest that digital instructional tools possess strong potential for supporting constructivist and learner-centred technical education. Nevertheless, important contextual differences remain evident. Most technology-related studies were conducted within relatively better-resourced educational environments and did not specifically examine AAC workshop-based instruction within developing-country TVET institutions. Consequently, while technology integration appears promising, its practical implementation within Nigerian AAC training environments may be constrained by infrastructural limitations, funding challenges, and unequal technological access. Research directly related to refrigeration and air-conditioning (RAC) instruction has begun to move closer to the focus of the present study. Kpabep and Festus (2019) developed a module for refrigeration leak detection, while Oluwatimilehin et al. (2021) explored the integration of mechatronics into RAC instruction. Both studies advocated curriculum reform, technical innovation, and teacher upskilling to improve training effectiveness. Compared to earlier studies that focused mainly on environmental concerns or technical deficiencies, these studies demonstrate a gradual shift toward instructional improvement within RAC education. However, despite these important contributions, the reviewed literature still reveals significant limitations. First, most studies addressed isolated technical issues, environmental concerns, or curriculum challenges rather than the comprehensive development and evaluation of a constructivist-based AAC teaching module. Second, empirical evidence directly examining constructivist instructional strategies within AAC-specific TVET contexts remains limited. Third, few studies simultaneously integrated environmental sustainability, technical competence, industry relevance, and pedagogical innovation into a unified instructional framework. Overall, the reviewed studies collectively highlight recurring challenges involving environmental safety, practical skill deficiencies, weak curriculum-industry alignment, infrastructural limitations, and unequal technological access within technical education. At the same time, they also demonstrate growing recognition of the importance of instructional innovation, practical competency development, and technology integration in vocational training.

Therefore, the present study addresses an important research gap by systematically developing a constructivist-based teaching module specifically for Automotive Air Conditioning within Nigerian TVET institutions. Unlike previous studies that focused primarily on technical problems or environmental concerns, this study integrates constructivist instructional principles, environmental safety awareness, practical competency development, and industry-relevant training into a comprehensive instructional framework designed to improve AAC teaching and learning outcomes within the Nigerian context. However, previous studies have shown how a teaching module under constructivism has been used successfully in a similar context.

Quality Appraisal of Included Studies

This section explains how the researcher ensured that the systematic review was trustworthy, accurate, and free from major bias. It describes the procedures used to evaluate the quality of the selected studies before combining their findings into the final review. The paragraph begins by stating that all selected studies were subjected to a quality appraisal process to ensure methodological rigour and reliability. Methodological rigour refers to the extent to which a study is carefully designed and conducted using acceptable scientific procedures. Reliability means that the findings are dependable and consistent. Before including any study in the review synthesis, the researcher critically examined whether the study met acceptable academic standards. The appraisal process was

guided by adapted principles from the Critical Appraisal Skills Programme and the Joanna Briggs Institute frameworks. These are internationally recognised tools commonly used in systematic reviews to assess the quality and credibility of research studies. The researcher adapted these frameworks to suit the educational and TVET context of the study, particularly automotive air conditioning (AAC) training.

The studies were evaluated using several important criteria:

- i. Clarity of research objectives: This examined whether the purpose and aims of each study were clearly stated and understandable.
- ii. Appropriateness of research design: This assessed whether the research methods used (qualitative, quantitative, or mixed methods) were suitable for answering the research questions.
- iii. Sampling adequacy: This checked whether the participants or the sample size were sufficient and properly selected.
- iv. Data collection procedures: This evaluated whether the instruments and procedures used for gathering data were appropriate and systematically applied.
- v. Analytical transparency: This determined whether the process of analysing the data was clearly explained and logically presented.
- vi. Validity and reliability of findings: This examined whether the results were accurate, credible, and consistent.
- vii. Relevance to AAC and TVET contexts: This ensured that the selected studies were directly related to automotive air conditioning and technical and vocational education and training.

After evaluation, the studies were grouped into three categories: high quality, moderate quality, and low quality. Studies considered high or moderate quality were retained for the final synthesis because they provided more credible evidence. Low-quality studies were excluded to minimise methodological weaknesses and bias that could affect the accuracy of the review findings.

Finally, the section explains that reliability was further strengthened through predefined review procedures and repeated cross-checking during screening, coding, and appraisal. This means the researcher consistently followed established steps throughout the review process and carefully rechecked extracted information to reduce errors and improve consistency in the analysis.

Table 3: Summary of the Findings

Theme	Supporting Studies	Evidence Summary (Synthesised Findings)
Teachers' Attitudes and Readiness Toward Constructivist Pedagogy	Umam et al. (2019); Tee et al. (2020); Yunos et al. (2020); Baroudi & Shaya (2022); Song & Sabran (2023)	The reviewed studies consistently indicate that teachers generally hold positive attitudes toward constructivist and learner-centred instructional approaches because they promote learner engagement, collaboration, problem-solving, and creative thinking. However, positive disposition alone does not ensure successful implementation. Adoption effectiveness was strongly influenced by teachers' pedagogical competence, instructional confidence, teaching experience, and professional self-efficacy. While experienced teachers demonstrated greater adaptability to innovative instructional approaches, inadequate pedagogical preparation and limited reflective practice reduced implementation effectiveness in some contexts.
Professional Development and	Umam et al. (2019); Tee et al. (2020); Yunos et al.	Evidence suggests that continuous professional development significantly strengthens teachers' capacity to implement

Teacher Competence Implementation Drivers	as (2020); Atukunda & Maja (2022)	constructivist instructional modules effectively. Training programmes improved instructional facilitation skills, learner-centred teaching competence, and readiness to integrate problem-solving pedagogies into vocational instruction. Nevertheless, several studies reported that teachers still struggled to apply higher-order instructional strategies due to limited pedagogical skills, curriculum overload, and insufficient institutional support. These findings imply that sustainable implementation requires ongoing professional development rather than one-time training interventions.
Instructional Materials, Technology Integration, and Learning Outcomes	Setiyani et al. (2020); Shaifuddin & Nashir (2022); Song & Sabran (2023); Çibukçiu (2025); Zhang & Ma (2025)	The reviewed studies demonstrate that digital instructional materials, e-resources, and constructivist learning strategies positively influence instructional delivery, learner engagement, communication skills, and learner independence. Constructivist approaches, including project-based learning (PBL), were also associated with improved academic achievement, critical thinking, and competency development. However, implementation outcomes varied considerably depending on technological access, teacher competence, and institutional readiness. While technology-supported instruction appears promising for technical education, the studies provided limited direct evidence regarding its application within AAC-specific workshop environments.
Institutional, Assessment, and Infrastructural Barriers to Implementation	Atukunda & Maja (2022); Tee et al. (2020); Ariyo et al. (2020); Onwusa (2021); Katcha & Mohammed (2022)	Several barriers were consistently identified across the reviewed studies, including inadequate assessment tools, insufficient instructional time, poor infrastructural facilities, weak evaluation systems, and unequal access to technological resources. Public institutions in developing contexts, particularly Nigeria, experienced greater implementation difficulties due to limited workshop facilities, inadequate ICT infrastructure, and insufficient institutional support. These challenges constrained teachers' ability to fully integrate constructivist and competency-based instructional strategies into practice-oriented vocational teaching.
Industry Collaboration, Contextual Factors, and TVET Implementation Challenges	Ariyo et al. (2020); Ismail et al. (2019); Yunos et al. (2020); Onwusa (2021); Katcha & Mohammed (2022)	The evidence highlights the importance of strong collaboration between educational institutions and industry for improving vocational relevance, employability, and practical skill acquisition. Industrial training programmes and entrepreneurship initiatives were found to strengthen graduate readiness when effectively integrated into vocational curricula. However, implementation effectiveness varied across countries and institutions due to differences in cultural conditions, infrastructural capacity, administrative support, and technological readiness. These findings suggest that constructivist module adoption must be context-sensitive rather than universally applied across all TVET systems.
Research Gap in AAC-Specific Constructivist	Umam et al. (2019); Shaifuddin & Nashir (2022); Ariyo et al. (2020); Onwusa (2021);	Although constructivist pedagogy, digital instructional materials, and learner-centred teaching approaches are widely discussed across general education and TVET literature, empirical evidence specifically focused on

Module Implementation	Katcha & Mohammed (2022)	Automotive Air Conditioning (AAC) training remains limited. Most reviewed studies addressed broader vocational, technical, or technology-based educational contexts rather than highly specialised AAC instructional environments. This gap highlights the need for contextually relevant constructivist teaching modules specifically designed for AAC training within Nigerian TVET institutions.
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Table 2 presents an analytical synthesis of the reviewed studies by grouping recurring findings into broader thematic categories relevant to constructivist teaching module adoption within TVET and Automotive Air Conditioning (AAC) contexts. The synthesis highlights similarities and differences across studies while also identifying contextual limitations, implementation barriers, and existing research gaps within AAC-specific instructional environments.

Table 4: Research questions and Summary of the results

S/N	Research Question	Results
RQ1	What attitudes do automotive TVET teachers hold?	The literature indicates that teachers generally show favourable attitudes toward constructivist strategies and learner-centred instructional modules, although their willingness is influenced by contextual realities such as resources, competence, and institutional support (Umam et al., 2019; Tee et al., 2020; Yunos et al., 2020).
RQ2	What factors influence adoption willingness?	Adoption is influenced by professional development, teacher competence, instructional resources, access to technology, and teacher self-efficacy (Baroudi & Shaya, 2022; Setiyani et al., 2020; Shai Fuddin & Nashir, 2022).
RQ3	What barriers hinder implementation?	Key barriers include limited infrastructure, inadequate funding, weak assessment systems, insufficient time allocation, and poor institutional support, particularly in public institutions (Onwusa, 2021; Atukunda & Maja, 2022; Ogunode et al., 2022).
RQ4	What strategies support successful implementation?	The most cited strategies include teacher training, technology-enhanced instructional materials, stronger curriculum-industry alignment, and structured module development (Sarwandi et al., 2019; Ariyo et al., 2020; Kpabep & Festus, 2019).
RQ5	How does constructivist module adoption affect teaching effectiveness and skill acquisition?	Evidence suggests that constructivist approaches such as project-based learning and problem-solving improve learning outcomes, thinking skills, and engagement, implying strong potential for improving competency-based AAC training (Zhang & Ma, 2025; Çibukçiu, 2025).

Thematic Synopsis: Evidence from the results

The reviewed studies generally indicate that teachers hold favourable attitudes toward constructivist and learner-centred instructional approaches, particularly those that encourage problem-solving, project-based learning, active participation, and practical skill development. However, the findings further suggest that positive teacher perceptions alone are inadequate for effective implementation. Successful adoption depends largely on teacher competence, professional development opportunities, instructional confidence, institutional support, and access to appropriate teaching resources. The synthesis also revealed that digital instructional materials and technology-supported learning tools can enhance instructional delivery, learner engagement, and teaching effectiveness within TVET contexts. Nevertheless, implementation effectiveness varies considerably across institutions due to infrastructural inequalities, limited technological access, inadequate training, and resource constraints, especially within Nigerian public schools and other resource-limited environments. In addition, several studies identified assessment limitations, inadequate evaluation mechanisms, and curriculum constraints as major barriers to the practical implementation of constructivist teaching modules. These challenges were particularly significant in practice-based vocational training, where competency assessment requires adequate workshop facilities, instructional materials, and industry-aligned evaluation systems.

Finally, the evidence consistently highlights the importance of industry institution collaboration, contextual adaptation, and curriculum relevance in strengthening vocational education outcomes. The findings suggest that constructivist instructional modules are more effective when aligned with labour market needs, local institutional realities, and the practical skill demands of technical disciplines such as Automotive Air Conditioning (AAC).

Study Selection (PRISMA Flow Results)

The systematic database search initially identified 6,871 records. Following the removal of 4,578 duplicate records, 2,293 unique studies remained for title and abstract screening. During this stage, 1,578 records were excluded because they were not directly relevant to the objectives of the review, including studies focused on general education, unrelated automotive topics, or student-only perspectives without emphasis on teacher attitudes or constructivist instructional practices. Subsequently, 715 reports were sought for retrieval; however, 648 records could not be accessed or retrieved due to availability limitations. As a result, 67 full-text articles progressed to the eligibility assessment stage. The full-text review was conducted using predefined inclusion and exclusion criteria. At this stage, 45 studies were excluded due to incomplete reporting, duplication, limited methodological relevance, or insufficient focus on constructivist teaching module adoption and implementation within TVET contexts. Ultimately, 22 studies satisfied all inclusion criteria and were retained for final synthesis. Overall, the structured PRISMA selection process enhanced the methodological transparency and rigour of the review by ensuring that only contextually relevant and methodologically appropriate studies contributed to the final analysis.

Overview of Included Studies

The final set of 22 studies represented diverse educational contexts, methodological approaches, and disciplinary focus areas relevant to constructivist teaching practices and technical skill development. The included literature covered vocational education and training systems across multiple countries, with notable representation from Nigeria and other developing contexts where TVET faces systemic challenges related to funding, infrastructure, and instructional resources (Ogunode et al., 2022; Onwusa, 2021). Several studies also examined instructional innovations such as multimedia learning, mobile learning, and e-instructional materials in technical and vocational settings (Sarwandi et al., 2019; Sutadji, 2020). While a subset of studies addressed automotive air conditioning and refrigeration-related training directly (Audu et al., 2022; Jiya et al., 2022; Kpabep & Festus, 2019; Oluwatimilehin et al., 2021), Many studies explored constructivist module adoption, technology integration, assessment practices, and teacher efficacy across broader TVET and technical education domains (Tee et al., 2020; Yunos et al., 2020). Collectively, the studies provided sufficient evidence to answer the review questions by highlighting key patterns in teacher attitudes, barriers to implementation, enabling factors, and the potential effects of adopting constructivist modules on learning outcomes.

Thematic Findings from the Included Studies

This systematic literature review synthesised evidence from 22 studies to explore automotive TVET teachers' attitudes toward constructivist teaching modules for automotive air conditioning training. The findings provide critical insight into teachers' perceptions, adoption drivers, implementation barriers, and the potential of constructivist teaching modules to enhance competency-based learning outcomes. The discussion interprets these findings in relation to TVET practice and the needs of automotive air conditioning training.

Teachers' Attitudes Toward Constructivist Teaching Modules

A dominant finding across the reviewed studies is that teachers generally hold positive perceptions of constructivist and learner-centred approaches, particularly those that enhance student participation and promote practical problem-solving. Teachers frequently recognised that constructivist instructional approaches encourage deeper engagement and improve learners' capacity to think critically and apply knowledge to real-world tasks (Umam et al., 2019; Tee et al., 2020). Similarly, comparative studies in vocational pedagogy found that TVET teachers in different contexts share similar teaching strategies aligned with student-centred instruction, although the level of application varies depending on institutional conditions (Yunos et al., 2020). implementation. Teachers' acceptance of constructivist teaching modules often depends on However, the review also revealed

that positive attitudes do not always translate into effective perceived feasibility, availability of instructional resources, and confidence in applying student-centred strategies in workshop settings (Song & Sabran, 2023; Baroudi & Shaya, 2022). Therefore, while attitudes are generally favourable, implementation is often conditional rather than automatic.

Factors Influencing Teachers' Willingness to Adopt Constructivist Modules

Table 3 shows that synthesis identified several interrelated factors influencing adoption. One key factor was teacher professional development, which repeatedly emerged as a strong predictor of readiness to adopt constructivist teaching modules. Constructivist-oriented training has been shown to strengthen teachers' instructional competence and enhance their ability to facilitate learning, thereby supporting professional growth and willingness to innovate (Umam et al., 2019; Tee et al., 2020). In technical domains, module implementation was also associated with the need for teacher upskilling, particularly in emerging skill areas such as mechatronics and modern system integration (Oluwatimilehin et al., 2021). Another important adoption factor was the availability of instructional materials and technology resources. Studies reported that teachers are more willing to adopt constructivist teaching modules when instructional resources such as digital learning materials, e-modules, and multimedia systems are accessible (Setiyani et al., 2020; Shaifuddin & Nashir, 2022). Teachers in technical education contexts also expressed preference for e-materials due to their ability to improve comprehension and simplify content delivery (Shaifuddin & Nashir, 2022). Similarly, mobile learning and multimedia-based instructional approaches were found to enhance engagement and support problem-solving, indicating that technology may function as an enabling tool for constructivist learning environments (Sarwandi et al., 2019; Sutadji, 2020).

Additionally, teachers' self-efficacy and professional identity significantly influenced willingness to adopt innovative approaches. Song and Sabran (2023) highlighted those personal experiences shape teacher confidence and teaching beliefs, while Baroudi and Shaya (2022) found that teaching experience was more strongly associated with teaching efficacy than training alone. These findings suggest that adoption willingness is shaped not only by external resources but also by internal psychological and professional readiness.

Barriers Hindering the Implementation of Constructivist Modules in Practical Training

The synthesis revealed that the most prominent barriers to constructivist module implementation relate to resource limitations, infrastructure constraints, and weak assessment systems. Technology adoption, although widely valued, was found to be limited in many public educational institutions due to poor infrastructure and insufficient access to ICT tools. Studies conducted in Nigeria showed that public schools experience greater challenges in implementing Microsoft tools and digital instructional materials compared to private schools, where resources are more available (Chukwutem, 2021); (Katcha & Mohammed, (2022). Funding constraints were also highlighted as a major barrier to educational development, particularly in higher institutions, where inadequate financial resources limit investment in facilities and instructional innovation (Ogunode et al., 2022). Assessment challenges were also widely reported as barriers. Atukunda & Maja (2022) found that lecturers struggled to complete curricula due to limited assessment tools and time constraints, while Tee et al. (2020) noted that although teachers value problem-solving and creative thinking, they often lack the skills required to integrate these into teaching and assessment. Similarly, Ariyo et al. (2020) reported that industrial field experience programmes lack adequate post-training evaluation mechanisms, limiting systematic monitoring of competency development. These findings suggest that even when teachers hold favourable attitudes toward constructivist modules, weak assessment structures can restrict implementation fidelity.

In addition, the review identified a persistent gap between theoretical knowledge and practical competence. Several studies documented deficiencies in diagnostic skills, maintenance competence, and hands-on training among learners and roadside mechanics. Ziblim et al., (2018) reported that mechanics lacked expertise in diagnostic tools and technical manuals, while Nkwachi, (2018) and OnyebueyiI, et al., (2018) reported that students lacked essential air conditioning installation and maintenance skills. These deficits are compounded by weak collaboration between training institutions and industries, which further limits effective skill transfer and real-world competence development. (Akinola et al., 2020).

Strategies Suggested for Supporting Successful Adoption and Implementation

The reviewed studies proposed multiple strategies to support the successful implementation of constructivist teaching modules. A central recommendation across the literature is continuous professional development for teachers. Teacher training programmes were consistently described as essential for equipping instructors with the competence needed to apply learner-centred pedagogies in technical subjects. (Umam et al., 2019 ;Tee et al., 2020). In RAC-related training, calls for teacher upskilling and curriculum reform were highlighted as necessary for integrating modern technological practices into teaching. (Oluwatimilehin et al., 2021). The use of digital instructional resources also emerged as a key strategy. Research showed that mobile learning tools, multimedia systems, and e-instructional materials improve learner engagement and enhance instructional effectiveness. (Sarwandi et al., 2019); Sutadji, 2020). Teachers' preference for e-materials further supports the relevance of digital modules as a pathway for strengthening constructivist teaching practices. (Shaifuddin & Nashir, 2022).

Furthermore, stronger industry–institution collaboration was repeatedly suggested as a strategic approach to improving TVET effectiveness. Ariyo et al., (2020) emphasised the importance of business–college partnerships in strengthening industrial field experience programmes, while Okolie et al., (2019) argued that higher education institutions must improve labour market alignment strategies to enhance employability outcomes. Similarly, entrepreneurship programmes were found to enhance graduate readiness when embedded systematically across training processes. Ismail et al., (2019). These findings suggest that constructivist teaching module implementation must be supported not only within institutions but also through partnerships with industry.

Effects of Constructivist Module Adoption on Teaching Effectiveness and Skill Acquisition

Evidence from the reviewed literature indicates that constructivist approaches have a generally positive impact on learning outcomes. Studies investigating constructivist teaching methods reported improved student performance, stronger academic achievement, and enhanced thinking skills. For instance, Çibukçiu (2025) confirmed that constructivist approaches significantly improved students' mathematical problem-solving performance. Similarly, Zhang et al. (2022) found that project-based learning produced significantly better learning outcomes than traditional teaching, contributing positively to academic achievement, affective attitudes, and thinking skills. These findings suggest that constructivist teaching modules can enhance learning effectiveness by promoting deeper engagement and skill development.

In technical education contexts, digital instructional materials were also linked to improved communication skills and learner independence, supporting the view that instructional modules can strengthen teaching delivery and learner outcomes. (Setiyani et al., 2020). Likewise, multimedia and mobile learning approaches were found to enhance student engagement and problem-solving, reinforcing the effectiveness of technology-supported constructivist strategies. (Sarwandi et al., 2019; Sutadji, 2020). However, the review revealed that despite evidence of effectiveness in broader educational contexts, empirical research directly evaluating constructivist teaching modules in automotive air conditioning training remains limited. Most AAC-related studies focused on hazards, environmental safety concerns, or technical competence gaps rather than structured pedagogical interventions. (Audu et al., 2022 ;Jiya et al., 2022; Nkwachi, 2018). This reinforces the relevance of future intervention-based research and module development in AAC training.

DISCUSSION

Implications for Policy, Practice, and Research

The findings of this review have important implications for policy, educational practice, and future research within TVET and Automotive Air Conditioning (AAC) training contexts. From a practical perspective, TVET institutions and teacher training centres should strengthen continuous professional development programmes that integrate pedagogical competence, technical upskilling, and constructivist instructional strategies. The findings suggest that the successful implementation of learner-centred modules depends not only on teachers' positive attitudes but also on their instructional readiness, confidence, and ability to facilitate practical competency-based learning. From a policy perspective, the review highlights the need for increased investment in workshop facilities, digital instructional technologies, refrigeration equipment, and institutional infrastructure, particularly within public TVET institutions where resource limitations remain significant barriers to

implementation. Curriculum reform is also necessary to improve the integration of competency-based assessment, environmental sustainability, industry-relevant skills, and modern automotive technologies into AAC training programmes. The review further emphasises the importance of strengthening collaboration between TVET institutions and industry to improve practical skill acquisition, workplace relevance, and graduate employability. From a research perspective, the limited empirical evidence specifically examining the constructivist teaching module in implementation within AAC training environments indicates the need for further context-specific investigation. Future studies should focus on the systematic design, implementation, and evaluation of AAC-specific constructivist teaching modules using rigorous methodological approaches such as quasi-experimental, mixed-method, and longitudinal research designs.

Summary of Discussion

In summary, this systematic review synthesised evidence from 22 studies examining teachers' attitudes toward constructivist teaching modules and their relevance to Automotive Air Conditioning (AAC) training within TVET contexts. The findings generally indicate that teachers hold favourable perceptions toward learner-centred and constructivist instructional approaches because of their potential to improve learner engagement, problem-solving ability, and practical competency development. The review further identified several factors influencing successful adoption and implementation, including teacher professional development, instructional competence, self-efficacy, access to instructional materials, technological readiness, and institutional support. At the same time, persistent challenges such as inadequate infrastructure, limited workshop facilities, weak assessment systems, insufficient funding, and poor industry collaboration were found to constrain implementation effectiveness, particularly within resource-constrained educational environments. The findings also revealed increasing concern regarding environmental sustainability, refrigerant safety, and workplace competence within AAC-related training. However, despite the generally positive evidence supporting constructivist instructional approaches across broader TVET contexts, direct empirical studies specifically focused on AAC instructional module implementation remain limited. Consequently, the conclusions of this review should be interpreted within the context of the available evidence base, which draws substantially from broader vocational and technical education literature. Overall, the review shows that constructivist teaching methods have great potential for enhancing competency-based learning in AAC training. It also emphasises the necessity for more targeted and context-specific instructional research within Nigerian TVET institutions.

Final Conclusion

This systematic review examined the existing literature on teachers' attitudes toward constructivist teaching modules and their relevance to Automotive Air Conditioning (AAC) training within TVET education. The findings indicate that constructivist instructional approaches may contribute positively to learner engagement, practical skill development, problem-solving ability, and competency-based learning outcomes. The review also demonstrates that successful implementation depends on multiple interconnected factors, including teacher competence, professional development, instructional confidence, institutional infrastructure, assessment systems, technological readiness, and industry collaboration. Although teachers generally demonstrated favourable attitudes toward learner-centred instruction, implementation effectiveness varied considerably across institutional and contextual settings. Importantly, the review identified significant limitations within the existing literature. Most of the reviewed studies focused broadly on TVET, technical education, or digital instructional practices rather than directly evaluating constructivist teaching modules within AAC-specific training environments. Consequently, while the broader evidence suggests promising instructional potential, there remains inadequate direct empirical evidence to make broad generalisations regarding AAC implementation effectiveness. Therefore, the review strongly supports the need for context-specific constructivist teaching module development and empirical evaluation within Nigerian TVET institutions. Such efforts may contribute to improving technical competence, environmental safety awareness, instructional effectiveness, and employability outcomes within Automotive Air Conditioning training programmes.

Future Research Directions

Future research should focus on the systematic development and empirical evaluation of constructivist teaching modules specifically designed for Automotive Air Conditioning (AAC) training within Nigerian TVET institutions. There is a need for intervention-based studies employing rigorous methodological approaches such

as experimental, quasi-experimental, mixed-method, and longitudinal research designs to evaluate the effectiveness of constructivist AAC modules on learners' psychomotor competence, diagnostic accuracy, technical problem-solving ability, and workplace readiness. Further studies should also investigate teachers' attitudes and behavioural readiness toward constructivist module adoption using established theoretical frameworks such as the Technology Acceptance Model and the Theory of Planned Behaviour to provide a deeper understanding of instructional adoption behaviour, implementation intention, and contextual influences. In addition, future research should explore how sustainability-focused instructional components, environmental safety practices, and refrigerant management training can influence technician behaviour and reduce environmental hazards within automotive servicing environments. More AAC-specific comparative studies across different institutional and regional contexts are also necessary to strengthen the contextual applicability and empirical foundation of constructivist instructional practices within technical vocational education.

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