

Implementing Blended Pedagogies in Automotive Repair and Maintenance Instruction: Evidence from TVET Colleges in KwaZulu-Natal, South Africa

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Abstract

The increasing digitalisation of the automotive industry has intensified the need for Technical and Vocational Education and Training (TVET) colleges to integrate digital technologies with practical instruction to prepare graduates for contemporary workplaces. Despite the recognised educational value of blended pedagogical approaches, their implementation within Automotive Repair and Maintenance (ARM) programmes in TVET colleges remains inconsistent and insufficiently understood. This study explored how lecturers implement blended pedagogical approaches in ARM instruction and examined factors influencing their implementation. Guided by the Technological Pedagogical Content Knowledge (TPACK) framework, the study adopted a qualitative multiple-case design within an interpretivist paradigm. The study was conducted in 2026 at four TVET colleges in KwaZulu-Natal, South Africa. The four participating colleges were selected through convenience sampling, while eight ARM lecturers were purposively selected from the participating colleges. Data were generated through semi-structured interviews, non-participant classroom and workshop observations, and document analysis, and analysed using Braun and Clarke's thematic analysis. Findings indicate that lecturers implemented blended pedagogical approaches through combinations of face-to-face instruction, digital technologies, and practical workshop activities. However, implementation was constrained by limited technological competence, inadequate digital infrastructure, outdated curriculum content, and insufficient institutional support. The study contributes to blended pedagogy scholarship by showing that effective technology integration depends on lecturers' technological, pedagogical, and content knowledge as well as on supportive institutional conditions that enable pedagogical innovation. The study recommends strengthening lecturers' professional development, improving digital infrastructure, and aligning ARM curricula with emerging automotive technologies to enhance the quality and relevance of vocational education.

Keywords: automotive repair and maintenance, blended pedagogy, technological pedagogical content knowledge), digital technologies integration, TVET colleges

1. Introduction

Technical and Vocational Education and Training (TVET) institutions play a central role in preparing graduates with the technical knowledge, practical competencies, and professional skills required for increasingly complex and technology-driven workplaces. As industries undergo rapid digital transformation, vocational education is expected to evolve accordingly to ensure that graduates possess the competencies required by modern labour markets (Yamada & Otchia, 2021). This expectation is particularly relevant in Automotive Repair and Maintenance (ARM), where technological advances such as electronic diagnostic systems, computerised vehicle management, and digital service technologies are reshaping workplace practices. Consequently, lecturers are expected to prepare students not only to master traditional mechanical skills but also to competently use digital technologies within authentic automotive environments (Bilbao-Ubillos et al., 2021; Maksum et al., 2024).

Responding to these developments requires teaching approaches that effectively integrate theoretical learning with practical application and technology-enhanced instruction. Blended pedagogical approaches, which purposefully combine face-to-face teaching with digital learning technologies, have gained increasing attention as an effective means of strengthening vocational education. Research suggests that blended pedagogies promote learner engagement, encourage self-directed learning, improve access to instructional resources, and strengthen the connection between classroom learning and workplace practice (Poti et al., 2022; Zwezwe, 2022). Within ARM programmes, blended pedagogies enable lecturers to combine practical workshop activities with digital resources such as learning management systems, multimedia demonstrations, simulations, and diagnostic technologies, thereby supporting both conceptual understanding and the development of industry-relevant competencies (Divaharan & Chia, 2022). Such instructional approaches align closely with the evolving requirements of the contemporary automotive industry, where graduates are increasingly expected to show both technical expertise and digital competence.

Despite these recognised benefits, the implementation of blended pedagogical approaches in South African TVET colleges remains inconsistent. Earlier research has identified several barriers to effective implementation, including inadequate digital infrastructure, limited institutional support, insufficient professional development opportunities, and varying levels of lecturers' technological competence (Brenya, 2024; Govender & Dhurumraj, 2022; Mesuwini & Mokoena, 2024). These challenges are particularly significant within vocational programmes because effective learning depends on the meaningful integration of theoretical instruction with authentic practical experiences. Although the Department of Higher Education and Training continues to prioritise the preparation of skilled artisans capable of participating in a technologically advanced economy, many lecturers still experience difficulties integrating educational technologies into their everyday teaching practices (McPherson, 2021). As a result, students may graduate without the technological competencies increasingly required by the modern automotive sector.

Understanding lecturers' implementation of blended pedagogical approaches is therefore essential for improving vocational teaching and learning. The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006, 2009) provides an appropriate theoretical lens because it conceptualises effective teaching as the interaction of technological, pedagogical, and content knowledge. Rather than viewing technology as an independent instructional tool, TPACK emphasises that meaningful technology integration depends on lecturers' ability to combine disciplinary knowledge with appropriate pedagogical strategies and digital technologies. Within ARM instruction, the framework provides a valuable perspective for examining how lecturers integrate educational technologies into classroom and workshop teaching to enhance students' theoretical understanding and practical competence.

Although blended learning and technology integration have been widely investigated within higher education and broader TVET contexts (Heikkilä et al., 2020; Kogo, 2022; Freimann & Magnus, 2023; Abdullah & Masek, 2024; Mesuwini & Mokoena, 2024), comparatively little empirical research has examined how lecturers implement blended pedagogical approaches specifically within ARM programmes in South African TVET colleges. Existing studies have largely focused on technology adoption, online learning, or lecturers' digital competencies in general, providing a limited understanding of how technological, pedagogical, and disciplinary knowledge intersect within vocational programmes where theoretical instruction must be integrated with authentic workshop practice. This gap is particularly evident within ARM, where graduates are expected to acquire both advanced practical competencies and digital capabilities required by an increasingly technology-driven automotive industry. Addressing this gap is important for informing lecturer professional development, strengthening institutional support, modernising curriculum implementation, and improving the quality of vocational education. Because the study sought to understand lecturers' instructional practices, experiences, and the contextual factors shaping blended pedagogical implementation, a qualitative multiple-case study was considered appropriate. This design enabled an in-depth exploration of blended pedagogical practices across different institutional contexts and generated rich insights into how lecturers integrated technology, pedagogy, and disciplinary knowledge in ARM instruction through the lens of the TPACK framework.

Therefore, this study explored lecturers' implementation of blended pedagogical approaches in ARM instruction within selected TVET colleges in KwaZulu-Natal. Specifically, the study sought to answer the following research questions:

1. How do lecturers implement blended pedagogical approaches in Automotive Repair and Maintenance instruction?
2. What factors influence lecturers' implementation of blended pedagogical approaches in Automotive Repair and Maintenance instruction?

This study contributes to the growing scholarship on blended pedagogy in vocational education by providing empirical evidence from ARM programmes, a context that remains underrepresented within existing TVET research. Guided by the TPACK framework, the study shows that effective blended pedagogy extends beyond technology adoption to encompass the dynamic interaction between lecturers' technological, pedagogical, and disciplinary knowledge within

supportive institutional environments. By highlighting the contextual factors that enable or constrain blended pedagogical implementation, the study offers evidence-based insights for lecturer professional development, curriculum enhancement, institutional policy, and the broader advancement of technology-enhanced vocational education. Beyond addressing the identified empirical gap, this study advances scholarship on blended pedagogy in TVET by showing that the implementation of blended pedagogical approaches in ARM is shaped by lecturers' technological, pedagogical, and content knowledge and the interaction of institutional resources, curriculum relevance, and industry expectations. By providing empirical evidence from South African TVET colleges, the study offers a contextually grounded understanding of technology-enhanced vocational teaching and generates practical insights to inform lecturer professional development, curriculum renewal, institutional support strategies, and policy aimed at strengthening vocational education in the digital era.

2. Literature Review

2.1 Blended Pedagogical Approaches in Vocational Education

Blended pedagogical approaches have become increasingly prominent in vocational education because they provide opportunities to integrate face-to-face teaching with digital learning technologies in ways that strengthen both theoretical understanding and practical competence. Unlike traditional teacher-centred instruction, blended pedagogies create interactive learning environments that combine classroom teaching, online learning resources, collaborative activities, practical demonstrations, and self-directed learning (Kumar et al., 2021; Krismadinata et al., 2020). Such integration is particularly valuable in competency-based programmes, where learners are expected to apply theoretical knowledge in authentic workplace contexts.

Within ARM instruction, blended pedagogies enable lecturers to combine practical workshop activities with digital technologies such as multimedia demonstrations, learning management systems, simulations, and diagnostic software. This integration enhances learner engagement, promotes independent learning, and strengthens students' readiness for digitally transformed workplaces (Abdullah & Masek, 2024; Vaughan et al., 2023). Rather than replacing practical instruction, blended pedagogies extend learning beyond the workshop by allowing students to revisit demonstrations, access learning materials, and consolidate theoretical concepts before engaging in practical tasks.

Despite these educational benefits, successful implementation depends on more than the availability of digital technologies. Effective blended pedagogy requires lecturers to integrate technology purposefully within appropriate pedagogical strategies and disciplinary content. Existing studies consistently show the value of blended learning for improving student engagement and learning outcomes but provide comparatively limited understanding of how lecturers implement blended pedagogical approaches within discipline-specific vocational programmes such as ARM. Consequently, greater attention is needed to the instructional practices through which lecturers integrate theory, technology, and authentic workshop experiences within TVET contexts.

2.2 Educational Technologies Supporting Automotive Repair and Maintenance Instruction

Educational technologies have become integral to the implementation of blended pedagogical approaches in vocational education because they support the integration of theoretical instruction with practical skill development. In ARM, technologies such as Learning Management Systems (LMS), virtual simulations, Augmented Reality (AR), Virtual Reality (VR), multimedia demonstrations, and digital diagnostic tools provide opportunities for students to engage with complex automotive systems before performing practical tasks in workshop environments.

Learning Management Systems such as Moodle, Blackboard, and Canvas facilitate the distribution of instructional materials, communication, formative assessment, and timely feedback (Turnbull et al., 2022; Ahmed & Ganapathy, 2021). Virtual Reality enables students to practise complex procedures, including engine assembly and disassembly, in safe simulated environments, while AR supports real-time visualisation of vehicle components during maintenance activities (Lan et al., 2023; Dargan et al., 2023). In addition, digital diagnostic scanners, multimedia demonstrations, and replica artefacts allow lecturers to represent complex automotive concepts more effectively and expose students to technologies that are increasingly used within contemporary automotive industries.

Although these technologies have considerable potential to enhance vocational teaching and learning, the literature consistently indicates that technology itself does not improve educational outcomes. Rather, meaningful learning depends on lecturers' ability to integrate technological tools within appropriate pedagogical approaches and disciplinary content. Consequently, the effectiveness of educational technologies is determined less by their availability than by how they are used to facilitate students' conceptual understanding, practical competence, and professional readiness.

2.3 Factors Influencing Lecturers' Implementation of Blended Pedagogical Approaches

The implementation of blended pedagogical approaches is shaped by multiple interrelated factors operating at lecturer, institutional, and student levels. Among lecturer-related factors, technological competence, pedagogical knowledge,

confidence, attitudes towards technology, and previous teaching experience consistently influence lecturers' willingness and ability to integrate digital technologies into their instructional practices (Anthony, 2022; Kundu & Bej, 2022). Although many TVET lecturers possess extensive disciplinary and industry expertise, studies indicate that they often receive limited preparation in digital pedagogy, reducing their confidence to implement blended learning effectively (Mesuwini & Mokoena, 2024).

Institutional conditions similarly influence implementation. Adequate digital infrastructure, reliable internet connectivity, access to modern workshop technologies, institutional leadership, and continuous professional development create enabling conditions for successful blended pedagogy (Bond et al., 2021; UNESCO, 2024; Williams et al., 2024). Conversely, inadequate resources and limited institutional support frequently constrain lecturers' capacity to integrate educational technologies meaningfully into vocational teaching.

Student-related factors also affect the effectiveness of blended pedagogies. Learners' digital literacy, motivation, access to digital devices, and internet connectivity influence their ability to engage with technology-enhanced learning environments. Where students experience limited access to technological resources beyond the classroom, the continuity of blended learning is often compromised.

Although previous studies identify these factors independently, comparatively little attention has been given to how they interact within competency-based ARM programmes. Consequently, understanding how lecturers negotiate these interconnected influences remains essential for strengthening blended pedagogical implementation within South African TVET colleges.

2.4 Synthesis of the Literature and Identified Research Gap

The reviewed literature shows growing consensus that blended pedagogical approaches strengthen student engagement, support practical skill development, and enhance graduate preparedness for increasingly digital workplaces. The literature further identifies lecturer competence, institutional support, and access to educational technologies as important determinants of successful implementation. Nevertheless, three important gaps remain.

First, most existing studies examine blended learning within higher education or general vocational education, with comparatively limited attention devoted to ARM programmes. Second, previous research has focused predominantly on technology adoption and digital learning environments rather than on how lecturers integrate technological, pedagogical, and disciplinary knowledge during vocational instruction. Third, limited empirical evidence exists regarding the implementation of blended pedagogical approaches within South African TVET colleges, where contextual factors such as resource constraints, curriculum relevance, and institutional support significantly shape teaching practice.

Addressing these gaps provides an opportunity to develop a more contextually grounded understanding of blended pedagogy in vocational education. Guided by the TPACK framework, the present study therefore explores how lecturers implement blended pedagogical approaches in ARM instruction and examines the factors influencing their implementation.

3. Theoretical Framework

3.1 The Technological Pedagogical Content Knowledge (TPACK) Framework

This study is underpinned by the TPACK framework developed by Mishra and Koehler (2006). The framework provides a comprehensive perspective for understanding how lecturers integrate technology into teaching by emphasising the dynamic interaction between technological, pedagogical, and content knowledge. Given that this study explored lecturers' implementation of blended pedagogical approaches in ARM instruction, Technological Pedagogical Content Knowledge provides an appropriate analytical lens because effective blended pedagogy depends not simply on the availability of digital technologies but on lecturers' ability to integrate technology meaningfully with appropriate pedagogical strategies and disciplinary knowledge.

The TPACK framework extends Shulman's (1986, 1987) concept of PCK, which proposed that effective teaching requires more than mastery of subject content; it also requires the ability to transform that knowledge into forms that facilitate student learning. Recognising the increasing role of digital technologies in education, Mishra and Koehler (2006) expanded this model by incorporating Technological Knowledge (TK) as a third knowledge domain. Consequently, TPACK conceptualises effective teaching as the integration of technology, pedagogy, and content rather than viewing these forms of knowledge independently (Koehler & Mishra, 2008; Yeh et al., 2021). This integrated perspective is particularly relevant to vocational education, where lecturers are expected to combine theoretical instruction, practical workshop experiences, and educational technologies to prepare students for increasingly digital workplaces.

Although the TPACK framework comprises seven interrelated knowledge domains—Content Knowledge (CK),

Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK)—this study focuses specifically on TK, TPK, TCK, and TPACK because these domains most directly explain lecturers' implementation of blended pedagogical approaches. Rather than examining technology use in isolation, the study investigates how lecturers combine technological expertise with pedagogical decision-making and disciplinary knowledge to enhance Automotive Repair and Maintenance instruction.

3.2 Applying TPACK to Blended Pedagogical Approaches in Automotive Repair and Maintenance Instruction

Technological Knowledge refers to lecturers' ability to use and adapt educational technologies in teaching and learning (Jaipal-Jamani & Figg, 2010). In ARM, this includes LMS, multimedia, online platforms, digital diagnostic scanners, simulations, and communication technologies such as WhatsApp. In this study, TK provided a lens for examining lecturers' confidence and competence in using these technologies to support blended pedagogy.

Technological Pedagogical Knowledge concerns understanding how technology influences teaching strategies and learning processes (Koehler & Mishra, 2009). In blended learning environments, technology should not merely supplement traditional instruction but should support learner-centred pedagogical practices such as demonstrations, collaborative learning, scaffolding, formative assessment, and guided practical activities. Consequently, TPK enabled the study to examine how lecturers selected and integrated digital technologies to support learner-centred strategies, including demonstrations, collaboration, scaffolding, formative assessment, and guided practical activities.

Technological Content Knowledge refers to understanding how technology can represent and transform subject-specific knowledge (Cox & Graham, 2009). Within Automotive Repair and Maintenance, educational technologies can be used to demonstrate complex automotive systems, illustrate engine diagnostics, visualise vehicle components, and simulate maintenance procedures that may otherwise be difficult to observe in traditional workshop settings. The TCK domain therefore enabled the study to examine how lecturers used technology to strengthen students' conceptual understanding and practical competence in Automotive Repair and Maintenance.

Technological Pedagogical Content Knowledge represents the integrated knowledge required to combine technology, pedagogy, and disciplinary content to facilitate meaningful learning (Mishra & Koehler, 2006; Cox & Graham, 2009). Within this study, TPACK provided the overarching framework for understanding how lecturers implemented blended pedagogical approaches by integrating digital technologies with appropriate teaching strategies and Automotive Repair and Maintenance content. Rather than considering technology, pedagogy, and content as separate components, TPACK conceptualises their interaction as the foundation of effective technology-enhanced vocational teaching instruction.

The TPACK framework therefore extends beyond explaining lecturers' use of educational technologies; it provides an analytical lens for understanding how lecturers design, implement, and adapt blended pedagogical approaches within the contextual realities of South African TVET colleges. It also acknowledges that effective technology integration is influenced by institutional conditions such as infrastructure, professional development opportunities, curriculum relevance, and organisational support. Accordingly, the framework guided the development of the interview protocol, classroom and workshop observation schedule, and document analysis, while also informing the thematic analysis and interpretation of the findings. By linking lecturers' technological, pedagogical, and disciplinary knowledge with the broader institutional context, TPACK provides a coherent framework for explaining both the opportunities and challenges associated with implementing blended pedagogical approaches in Automotive Repair and Maintenance instruction.

4. Method

4.1 Research Approach and Design

This study adopted a qualitative research approach within an interpretivist paradigm to explore how lecturers implement blended pedagogical approaches in ARM instruction in selected TVET colleges in KwaZulu-Natal. A qualitative approach was appropriate because the study sought to understand lecturers' instructional practices, experiences, and the contextual factors influencing the implementation of blended pedagogical approaches within authentic educational settings (Creswell & Creswell, 2017; Alhazmi & Kaufmann, 2022). Rather than measuring the extent of technology use, the study aimed to generate an in-depth understanding of how lecturers integrated technological, pedagogical, and disciplinary knowledge in their teaching.

An interpretivist multiple-case study design was employed to facilitate an in-depth exploration of blended pedagogical implementation across four TVET colleges. Interpretivism assumes that educational realities are socially constructed and are best understood through participants' experiences and meanings within their specific contexts (Lincoln et al., 2022; Acharya, 2024). The multiple-case study design enabled the researcher to examine blended pedagogical practices within each institution while identifying similarities and contextual differences across cases (Cleland et al., 2021; Yin,

2018). The design complemented the TPACK framework by enabling an examination of how lecturers integrated technology, pedagogy, and Automotive Repair and Maintenance content within authentic vocational teaching environments.

4.2 Research Setting, Participants and Sampling

The study was conducted in four public TVET colleges in KwaZulu-Natal, South Africa, offering the National Certificate (Vocational) (NC(V)) ARM programme. The target population comprised ARM lecturers across the nine public TVET colleges in KwaZulu-Natal offering ARM programmes. All nine colleges were invited to participate; however, only four granted institutional permission. These four colleges therefore constituted the accessible population and represented urban, peri-urban, and rural contexts, providing relevant contextual variation for examining blended pedagogical approaches.

At the institutional level, the four participating colleges were selected through convenience sampling based on accessibility and willingness to participate. Within each college, two ARM lecturers were purposively selected based on their direct experience in teaching ARM and implementing or attempting to implement blended pedagogical approaches, resulting in a final sample of eight lecturers. Selecting two lecturers per college provided more than one perspective within each institutional case and enabled comparison across the four sites. Pseudonyms (L1-L8) were assigned to participants and institutions to maintain confidentiality.

The sample of eight lecturers was considered appropriate for the qualitative multiple-case design, which prioritised depth and information richness rather than statistical representativeness. Thematic saturation was not explicitly monitored or used as a formal criterion for determining when data generation ceased; therefore, saturation by the eighth interview/observation set is not claimed. Sample adequacy was instead considered in relation to participants' relevance and information richness, the four institutional cases, and the use of multiple data sources. Each college was analysed as an individual case before cross-case comparison, enabling recurring patterns and contextual differences to be identified. Participant demographic characteristics are presented in Table 1.

Table 1. Demographic Profile of Participant

Participant	Gender	Teaching Experience	Qualifications	Digital Training
L1	Male	9 years	B-Ed Hons	No formal training
L2	Female	5 years	B-Tech	No formal training
L3	Male	11 years	B.Ed. (Tech), PGDip	DHET workshops
L4	Female	7 years	B.Ed. Hons	College-based training
L5	Male	15 years	Advanced Certificate in Education	Self-taught and peer-supported
L6	Male	12 years	M.Ed. + Trade Test (Diesel Mechanics)	Industry-based training
L7	Male	8 years	NDip + B.Tech	Provincial e-learning programme
L8	Male	6 years	M.Ed	Blended Learning Certificate

As shown in Table 1, the 8 participants had between 5 and 15 years of teaching experience and varied in their academic and professional qualifications and exposure to digital technology training. Six participants were male and two were female. Their varying levels of professional experience and digital exposure provided diverse perspectives on the implementation of blended pedagogical approaches in ARM instruction.

4.3 Data Collection

Data were generated through semi-structured interviews, non-participant classroom and workshop observations, and document analysis, enabling methodological triangulation and enhancing the credibility of the findings (Lincoln & Guba, 1985; Lune & Berg, 2017). Semi-structured interviews were guided by an interview schedule informed by the TPACK framework and explored lecturers' technological, pedagogical, and content knowledge, their implementation of blended pedagogical approaches, and associated opportunities and challenges (Tracy, 2021; Creswell & Poth, 2022). Each interview lasted approximately 20–30 minutes and was audio-recorded with participants' informed consent.

Non-participant observations were conducted in classroom and workshop settings using a TPACK-aligned observation schedule to examine instructional strategies, technology integration, student engagement, lecturer–student interactions, and instructional decision-making (Barrios et al., 2024). Each of the eight lecturers was observed twice, once in a classroom and once in a workshop, resulting in 16 observation sessions. Structured observation templates, contextual field notes, and reflective memos were used to record the observations. Participants were informed that the observations were not evaluative, and a non-intrusive approach was adopted to minimise disruptions.

Document analysis complemented the interview and observation data by providing contextual evidence of how blended pedagogical approaches were planned, supported, and implemented (Davie & Wyatt, 2021; Kutsyuruba, 2023). A TPACK-informed document-analysis checklist guided the review of lesson plans and work schedules, assessment tasks

and rubrics, institutional frameworks and policies, and course outlines or subject guidelines. These documents provided evidence of instructional planning, assessment practices, curriculum expectations, technology integration, and institutional support. Documentary evidence was reviewed alongside interview and observation data to corroborate participants' accounts and identify convergence and divergence across the data sources. Table 2 summarises the observational and documentary evidence generated across the four participating colleges.

Table 2. Summary of observational and documentary data generated

Participating College	Classroom observations	Workshop observation	Total observations	Document evidence reviewed
College 1	2	2	4	Lesson plans and work schedules; assessment tasks and rubrics; institutional policies; course outlines or subject guidelines
College 2	2	2	4	Lesson plans and work schedules; assessment tasks and rubrics; institutional policies; course outlines or subject guidelines
College 3	2	2	4	Lesson plans and work schedules; assessment tasks and rubrics; institutional policies; course outlines or subject guidelines
College 4	2	2	4	Lesson plans and work schedules; assessment tasks and rubrics; institutional policies; course outlines or subject guidelines
Total	8	8	16	Four categories of documentary evidence across the four participating colleges

Note: Each of the eight participating lecturers was observed twice, once in a classroom setting and once in a workshop setting. Documentary evidence was reviewed across four categories: lesson plans and work schedules; assessment tasks and rubrics; institutional frameworks/policies; and course outlines or subject guidelines.

4.4 Data Analysis

Interview transcripts, observation notes, and documentary evidence were analysed using Braun and Clarke's (2006, 2021) six-phase thematic analysis. The analysis began with repeated reading of the data to achieve familiarisation, followed by the generation of initial codes representing meaningful segments relevant to the research questions. Related codes were subsequently organised into categories and refined into broader themes that captured recurring patterns across participants and institutions.

Consistent with the multiple-case study design, each participating college was first analysed independently before cross-case comparisons were undertaken to identify similarities, differences, and contextual influences on blended pedagogical implementation (Stake, 2006; Yin, 2018). Throughout the analytical process, the TPACK framework served as the interpretive lens for understanding how lecturers integrated technological, pedagogical, and disciplinary knowledge in their teaching. Themes were supported by verbatim quotations, observation evidence, and documentary data to ensure rich and contextually grounded interpretation.

4.5 Trustworthiness and Ethical Considerations

Trustworthiness was ensured using Lincoln and Guba's (1985) criteria of credibility, transferability, dependability, and confirmability. Credibility was enhanced through methodological triangulation and member checking (Lune & Berg, 2017). Transferability was supported by providing rich descriptions of the research context, while dependability and confirmability were ensured through an audit trail, reflective field notes, and grounding interpretations in participants' accounts and observational evidence (Ahmed, 2024).

Ethical approval was obtained from the Durban University of Technology Institutional Research Ethics Committee before to data collection. Permission was subsequently granted by the relevant authorities and participating TVET colleges. Participation was voluntary, informed consent was obtained from all lecturers, and participants were informed of their right to withdraw without penalty. Confidentiality and anonymity were maintained through the use of pseudonyms, and all research data were securely stored and accessed only by the researcher.

5. Findings

The findings are presented according to the two research questions guiding the study. Data generated through semi-structured interviews, non-participant classroom and workshop observations, and document analysis were triangulated and analysed thematically. Across the four participating TVET colleges, lecturers implemented blended pedagogical approaches through varying combinations of digital technologies, learner-centred instructional strategies, and practical workshop activities. However, the depth and consistency of implementation differed across institutions

because of variations in lecturers' technological competence, institutional resources, curriculum relevance, and student readiness. The findings are presented under the themes that emerged from the data.

5.1 Implementation of Blended Pedagogical Approaches in Automotive Repair and Maintenance Instruction (RQ1)

Lecturers showed varying levels of competence in using digital technologies to support teaching and learning. All participants reported using basic digital technologies such as PowerPoint presentations, YouTube videos, and WhatsApp to present content, communicate with students, and share instructional resources. However, only a few lecturers incorporated industry-specific technologies, including automotive diagnostic scanners and simulation software, into classroom and workshop instruction.

One lecturer explained:

"I'm comfortable with using PowerPoint, videos and WhatsApp to keep in touch with students. But when it comes to some demonstration software, I still need help from the IT guy." (Lecturer 3)

By contrast, lecturers with previous industry experience integrated diagnostic scanners and electronic fault-finding software into practical lessons, enabling students to interact with technologies commonly used in modern automotive workshops. Classroom observations confirmed these differences. In some colleges, lecturers actively incorporated diagnostic equipment into practical demonstrations, whereas in others similar equipment remained unused because lecturers lacked confidence in operating it. Observations further showed that where only one diagnostic scanner was available, students had limited opportunities for hands-on practice because the equipment had to be shared among large groups.

Collectively, the interview, observation, and documentary evidence indicate that lecturers' use of digital technologies extended beyond basic communication tools where technological competence and institutional resources permitted. Nevertheless, unequal access to industry-specific technologies and differences in lecturers' confidence contributed to varying levels of blended pedagogical implementation across the participating colleges.

Theme 2: Integrating Digital Resources with Practical Workshop Instruction

The findings indicate that lecturers integrated digital resources into established vocational teaching practices rather than replacing traditional practical instruction. Across all four colleges, participants adopted a learner-centred sequence in which theoretical concepts were introduced through digital resources before being reinforced by practical demonstrations and workshop activities.

For example, one lecturer used YouTube demonstrations before practical engine dismantling sessions to familiarise students with workshop procedures, whereas another relied on printed diagrams because many students had limited internet access. Several lecturers also distributed instructional videos through WhatsApp to extend learning beyond scheduled classroom sessions.

Classroom observations indicated that lecturers consistently combined digital resources with practical demonstrations, one-on-one coaching, immediate feedback, and scaffolded workshop activities. However, overcrowded workshops and limited equipment frequently reduced opportunities for individual participation, prompting lecturers to organise students into peer-learning groups to maximise the available resources.

Taken together, the evidence shows that blended pedagogical approaches complemented rather than replaced practical workshop instruction. Digital technologies were primarily used to prepare students for practical learning, reinforce theoretical concepts, and extend learning beyond the classroom.

Theme 3: Strengthening Curriculum Delivery Through Disciplinary Expertise

The findings show that lecturers possessed strong disciplinary knowledge in ARM, particularly in relation to mechanical systems, diagnostics, and workshop safety. Classroom observations and document analysis revealed close alignment between lesson delivery, curriculum requirements, and practical workshop activities.

Despite this strength, lecturers consistently expressed concern that aspects of the prescribed curriculum no longer reflected contemporary automotive industry practices. Participants indicated that topics such as carburettor systems continued to receive considerable curriculum attention despite modern vehicles relying predominantly on electronically controlled fuel injection systems.

To address this limitation, several lecturers supplemented the prescribed curriculum with diagnostic scanners, simulation software, and examples drawn from their industry experience to expose students to emerging automotive technologies.

Overall, the evidence indicates that lecturers relied on strong disciplinary expertise to bridge gaps between the prescribed curriculum and current industry practice. Where resources and expertise were available, digital technologies were used to enrich curriculum delivery and expose students to contemporary automotive systems.

5.2 Factors Influencing The Implementation of Blended Pedagogical Approaches (RQ2)

The second research question explored the factors influencing lecturers' implementation of blended pedagogical approaches in ARM instruction. The findings reveal that a combination of institutional, student, and lecturer-related factors shaped the implementation of blended pedagogies. Although lecturers showed a strong commitment to integrating digital technologies into their teaching, the consistency and effectiveness of implementation varied according to the availability of institutional resources, students' readiness to engage with technology-enhanced learning, and lecturers' professional motivation. Three interrelated themes emerged from the data.

Theme 4: Institutional Resources as Enablers and Constraints

The findings indicate that institutional resources played a central role in shaping lecturers' implementation of blended pedagogical approaches. Although some lecturers successfully incorporated diagnostic scanners, simulation software, multimedia resources, and digital learning platforms into their teaching, the availability and accessibility of these technologies differed considerably across the participating colleges.

Classroom and workshop observations revealed shortages of diagnostic equipment, unreliable internet connectivity, outdated workshop technologies, and inadequate digital infrastructure. These limitations frequently constrained lecturers' ability to implement planned blended learning activities. Document analysis further showed that several lesson plans included activities requiring diagnostic equipment that could only be explained theoretically because the necessary resources were unavailable during practical sessions.

As a result, many lecturers adapted their teaching by relying on personal laptops, smartphones, printed instructional materials, and ageing workshop equipment to compensate for institutional resource limitations. Although these adaptations enabled lessons to continue, they reduced opportunities for students to engage directly with industry-standard technologies.

Collectively, the interview, observation, and documentary evidence indicate that institutional resources functioned both as enablers and constraints of blended pedagogical implementation. Colleges with greater access to digital infrastructure and modern workshop equipment showed more extensive integration of blended pedagogies than those experiencing persistent resource shortages.

Theme 5: Student Readiness for Blended Learning

Student readiness emerged as another important factor influencing blended pedagogical implementation. The findings indicate that students were generally enthusiastic about technology-enhanced learning, particularly when digital resources complemented practical workshop activities. Classroom observations consistently showed high levels of participation during practical demonstrations, collaborative troubleshooting exercises, and authentic workshop tasks where digital technologies were successfully integrated.

However, lecturers reported that students' engagement frequently depended on their access to reliable digital technologies. Unstable internet connectivity, software failures, and limited access to smartphones, laptops, and mobile data often interrupted learning activities and reduced opportunities for students to continue learning beyond scheduled class sessions.

Several lecturers explained that many students experienced financial constraints that limited their ability to purchase mobile data or access suitable digital devices. Consequently, lecturers frequently adjusted planned activities by providing printed learning materials or extending classroom-based explanations to ensure that students were not disadvantaged by unequal access to technology.

Taken together, the findings indicate that student engagement was influenced not only by lecturers' instructional practices but also by students' digital readiness and equitable access to technological resources, both within and beyond the college environment.

Theme 6: Lecturers' Professional Commitment to Blended Pedagogy

Despite the challenges associated with implementing blended pedagogical approaches, lecturers demonstrated a strong commitment to preparing students for employment within an increasingly digital automotive industry. Participants consistently described themselves as facilitators and mentors who sought innovative ways to integrate technology into teaching despite limited institutional support.

Several lecturers reported using their smartphones, privately owned diagnostic equipment, self-developed multimedia resources, and personal internet data to supplement institutional resources. Others described investing additional time in identifying online videos, developing digital learning materials, and adapting practical demonstrations to expose students to contemporary automotive technologies.

Nevertheless, lecturers also expressed frustration that limited institutional investment, inadequate professional

development opportunities, and insufficient recognition of innovative teaching practices reduced their capacity to sustain blended pedagogical innovation over time. Document analysis similarly revealed limited institutional acknowledgement of lecturers' efforts to integrate blended pedagogies, suggesting that innovation was largely driven by individual initiative rather than coordinated institutional strategies.

Overall, the evidence indicates that lecturers' professional commitment played a significant role in sustaining blended pedagogical implementation despite challenging institutional conditions. However, the findings also suggest that individual motivation alone was insufficient to ensure consistent implementation without complementary institutional support.

Cross-Case Synthesis

Across the four colleges, blended pedagogical implementation varied according to lecturers' technological competence, institutional resources, and student readiness. Colleges with greater access to relevant technologies enabled more consistent integration of digital tools into practical instruction, whereas resource-constrained colleges relied more heavily on basic digital tools and lecturers' personal initiatives. Overall, the cases show that the implementation of blended pedagogy in ARM is shaped by the interaction between lecturer capability, student readiness, and institutional context.

6. Discussion

The study explored how lecturers implement blended pedagogical approaches in ARM instruction and the factors influencing implementation in selected KwaZulu-Natal TVET colleges. Findings show that lecturers combined workshop-based instruction with digital technologies, but implementation varied according to technological competence, institutional support, curriculum relevance, and student readiness. Blended pedagogy, therefore, emerged as a continuum rather than a standardised model.

Viewed through TPACK, effective blended pedagogy depends on the interaction of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). Lecturers generally showed strong pedagogical expertise, whereas technological integration varied. Those with industry experience were more confident using diagnostic scanners, simulation software, and other industry-specific technologies, whereas others relied mainly on PowerPoint, YouTube, and WhatsApp. This reinforces the need to integrate technology purposefully with pedagogy and disciplinary knowledge (Koehler & Mishra, 2009), extending TPACK to competency-based ARM instruction in resource-constrained TVET contexts.

Institutional conditions also shaped implementation. Inadequate diagnostic equipment, unreliable connectivity, outdated technologies, and limited institutional support constrained blended pedagogy despite lecturers' willingness to use digital tools. This aligns with UNESCO (2024) and Abedi (2024), who emphasise digital infrastructure and institutional investment in technology-enhanced vocational education. Student engagement was stronger when digital tools complemented authentic workshop activities, although limited devices, connectivity, and mobile data presented barriers, consistent with Hashim et al. (2023).

Lecturers showed professional commitment by using personal devices, self-developed materials, diagnostic equipment, and industry experience. However, reliance on individual initiative is insufficient for sustainable implementation. The findings therefore highlight the need for continuous TPACK-orientated professional development, curriculum renewal, institutional investment, and equitable access to digital resources.

The study contributes theoretically by showing how TPACK operates within the institutional realities of ARM instruction and practically by identifying the need to strengthen digital infrastructure, content-specific technological competencies, curriculum alignment, and student access. Given the study's eight lecturers across four TVET colleges, the findings offer contextual rather than statistical generalisations. Nevertheless, triangulation of interviews, observations, and document analysis provides useful insights for comparable vocational education contexts.

Overall, effective blended pedagogy in ARM requires more than technology; it requires the purposeful integration of technology, pedagogy, and disciplinary knowledge within supportive institutional environments. Strengthening lecturers' TPACK, modernising curricula and workshop technologies, and improving equitable digital access are essential for preparing graduates for an increasingly digital automotive industry.

7. Conclusion

This study explored lecturers' implementation of blended pedagogical approaches in ARM instruction within selected TVET colleges in KwaZulu-Natal and examined the factors influencing their implementation. The findings show that blended pedagogy is not defined by the use of digital technologies alone but by the purposeful integration of technology, pedagogy, and disciplinary knowledge within authentic vocational learning environments. Although lecturers showed strong pedagogical and disciplinary expertise, the effective implementation of blended pedagogical approaches was shaped by differences in technological competence, institutional resources, curriculum relevance, and student readiness.

The study extends the application of the TPACK framework by showing that effective technology integration in vocational education depends not only on lecturers' knowledge but also on the institutional contexts in which teaching occurs. As the automotive industry continues to undergo rapid digital transformation, strengthening blended pedagogical approaches within TVET colleges will require coordinated investment in lecturer professional development, digital infrastructure, curriculum renewal, and institutional support to ensure that graduates are equipped with the knowledge, practical competencies, and digital capabilities required by contemporary workplaces.

8. Practical Implications and Professional Development Strategies

The findings suggest that professional development for ARM lecturers should move beyond general digital-literacy training towards TPACK-orientated and content-specific professional learning. Colleges should strengthen TK through training in relevant digital and learning technologies, while developing TCK through practical training on technologies directly related to contemporary ARM content, particularly electronically controlled vehicle diagnostics. Such training should enable lecturers not only to operate diagnostic technologies but also to understand how they can be used to teach specific automotive concepts and diagnostic procedures.

Professional development should also strengthen PK and PCK through strategies for teaching complex ARM concepts and practical procedures using learner-centred, problem-based, and blended approaches. Technological Pedagogical Knowledge can be developed by training lecturers to integrate simulations, digital demonstrations, diagnostic software, and other technologies into appropriate teaching and assessment strategies. Finally, colleges should provide opportunities for lecturers to integrate these dimensions through collaborative design, implementation, and reflection on blended ARM learning activities, thereby strengthening TPACK.

Professional development should therefore be continuous, practical, collaborative, and context-specific, enabling lecturers to connect technology with the specific content and pedagogical demands of ARM instruction rather than treating technology integration as a general digital competency.

9. Limitations and Future Research

This study was conducted in four public TVET colleges in KwaZulu-Natal and involved eight ARM lecturers. Consequently, the findings provide in-depth contextual insights rather than statistical generalisations. Future research could extend this work by including a larger number of TVET colleges across different provinces, incorporating students' perspectives on blended pedagogical approaches, and employing mixed-methods or longitudinal designs to examine how blended pedagogical implementation evolves over time. Further studies may also explore the effectiveness of emerging technologies such as Artificial Intelligence, Virtual Reality, and AR in strengthening vocational teaching and learning within ARM programmes.

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Author contributions

Mr Koketso Morudu contributed to data collection and analysis. Prof. Mogale Simon Albert Maeko contributed to drafting the manuscript, while Dr Douglas Thembinkosi Sotsaka contributed to revising the manuscript. All authors contributed equally to the study, read and approved the final version of the manuscript.

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