Eastern African Journal of Humanities and Social Sciences
Vol. 5 No. 1 (2026): ISSN (Online): 2958-4558
DOI: https://doi.org/10.58721/eajhss.v5i1.1729
Technological Ecology Theory: A TVET Lecturer Development Model for Understanding Human Development in Technological Environments

Technological Ecology Theory: A TVET Lecturer Development Model for Understanding Human Development in Technological Environments

Percy Thabiso Mhlanga & Thokozani Isaac Mtshali
Tshwane University of Technology, South Africa

Article History
Received: 2025-12-20
Revised: 2026-05-01
Accepted: 2026-05-04
Published: 2026-05-15

Keywords
Artificial Intelligence
Ecological Systems
Training
Vocational Education

How to cite:
Mhlanga, P. T., & Mtshali, T. I. (2026). Technological Ecology Theory (TET): A TVET Lecturer Development Model for Understanding Human Development in Technological Environments. *Eastern African Journal of Humanities and Social Sciences*, *5*(1), 288-298.

Abstract
The Technical and Vocational Education and Training (TVET) artificial intelligence field is becoming increasingly sophisticated and complex. Consequently, a deeper analysis was required of lecturer development in the face of the evolving technological environment. The emphasis on the specific characteristics of an individual does not consider the larger ecological and structural drivers of technological adoption. The report introduces Technological Ecology Theory (TET), an ecological model developed through a qualitative study exploring the relationship between Mechanical Engineering lecturers and AI. TET integrates the Ecological Systems Theory (EST), the Technological Pedagogical Content Knowledge (TPACK) framework, and the structural realities of TVET institutions. This integration provides a comprehensive ecological perspective on how lecturers adapt to AI within Technical and Vocational Education and Training (TVET) institutions, where challenges such as industry misalignment constrain effective AI integration and necessitate a contextualised model. The model portrays the lecturer training process in an ecological manner, which is shaped by organisational structures, environments surrounding teaching/learning, resource allocation and job-specific experience. Furthermore, the study highlights the importance of recognising multilevel influences on lecturer development, including institutional policies, community engagement, and technological infrastructure. By adopting TET, stakeholders in TVET can better design curriculum, training programmes, and support systems that address both individual competencies and the broader system dynamics impacting AI adoption. Ultimately, this ecological approach offers a framework to enhance the responsiveness and effectiveness of lecturer development, facilitating improved integration of AI technologies in teaching and learning.

Introduction

Vocational learning environments around the world are being redefined by digital transformation and Industry 4.0. South African TVET institutions require Mechanical Engineering lecturers to adopt artificial intelligence (AI), simulation software, and other advanced digital tools in their teaching practice. Despite ongoing training offerings, educators still frequently struggle to use these technologies effectively due to broader ecological and structural challenges. Workshop equipment is generally obsolete, including a widespread lack of Computer Numerical Control (CNC) machines (Akoojee, 2008; Buthelezi, 2018; Wedekind & Mutereko, 2021); there is also insufficient digital infrastructure and limited institutional support.

Existing models, such as Technological Pedagogical Content Knowledge (TPACK), tend to emphasise individual lecturers' skills without adequately accounting for the larger institutional ecology and structural constraints that critically shape technology integration (Schmidt et al., 2009). This gap points to a need for models that explain how multi-level environmental systems interact with lecturers' knowledge frameworks.

To address this, the study proposes the Technological Ecology Theory (TET), which integrates Bronfenbrenner's Ecological Systems Theory (EST) with TPACK to create an ecological model of lecturer development. This model situates lecturers within nested systemic layers from the microsystem of classroom practice, through departmental and institutional mesosystems, to national macrosystems such as South Africa's 4IR policies and dynamically links how these layers influence each other and impact the lecturer's ability to adopt AI technologies effectively. The model sheds light on human development in technological settings by highlighting the interconnections among people, systems, and structures.

Bronfenbrenner's Ecological Systems Theory (1979, 1994) has long been used to understand human development. According to empirical research that applies ecological principles to education, teacher technologies are shaped by a multi-level process involving culture, interdepartmental cooperation, institutional regulations, and national digital agendas (Aldridge & McChesney, 2018; Johnson, 2020). These ecological implications are further demonstrated in fast-moving technology environments. Research suggests that teachers' readiness to use technology is closely associated with factors such as infrastructure quality, leadership support, and institutional socio-economic conditions (Hennessy et al., 2018). Technological Ecology Theory builds on this body of scholarship by situating technological development within nested systemic conditions rather than personal attributes alone.

TPACK (Technological Pedagogical Content Knowledge)

The TPACK model (Mishra and Koehler 2006) argues that effective technology integration in teaching requires the integration of three key knowledge domains: technological, pedagogical, and content knowledge. A number of studies affirm that lecturers need to know more than technical skills; they must also understand how to integrate technology with discipline-specific pedagogy (Koehler et al., 2013; Chai, Koh, & Tsai, 2016). However, TPACK is challenged by scholars who argue that it may not capture environmental constraints on technology use (Brantley-Dias & Ertmer, 2013). However, this gap has been glaringly apparent in TVET colleges, where lecturers may already have sufficient technical insights but cannot apply that knowledge due to structural infrastructural deficiencies. TET addresses this gap by locating TPACK in ecological and structural systems.

Within the TPACK framework, artificial intelligence cannot be treated as a neutral extension of technology knowledge. Unlike static or delivery-based technologies, AI introduces adaptive, generative, and decision-support capabilities that dynamically reshape pedagogical and content interactions. As such, AI mediates not only how content is delivered but also how it is constructed, sequenced, and personalised in real-time, thereby reconfiguring the relationships among technological, pedagogical, and content knowledge.

TVET Education at the structural level

TVET colleges are facing an array of idiosyncratic challenges that are structurally related, such as outdated equipment, insufficient digital infrastructure, and inadequate investment in workshop upgrades (Akoojee, 2008; Buthelezi, 2018; Wedekind & Mutereko, 2021). Such structural realities make it challenging to introduce new technologies such as AI and digital simulations. Teacher development is found to be ineffective when institutional infrastructure is weak (Czerniewicz & Brown, 2014). Just like this, technological innovation will face fragmentation without encouraging organisational cultures and policies (Ng'ambi et al., 2016). TET treats these structural conditions as basic to teaching; its focus on lecturer development is not seen as an outside barrier.

Method

Research Approach

A qualitative research design was used to investigate the experiential approaches of Mechanical Engineering lecturers to technological change in TVET colleges. This qualitative approach was appropriate for examining the multifaceted relationships and interactions among personal, organisational, ecological, and structural components in lecturer development.

Participants and Sampling

Purposive sampling was used to recruit participants. We selected TVET colleges' Mechanical Engineering lecturers with experience of AI tools, simulations and digital systems. This involved early adopters and lecturers transitioning to new technologies as well. This study purposively sampled seven (7) TVET colleges across Gauteng province and sixteen Mechanical Engineering lecturers, with more than two lecturers per college offering the Mechanical Engineering scheme.

Data Collection

Semi-structured interviews were conducted to explore participants' experiences with technology, professional development, institutional support, and barriers to implementation. Interviews were accompanied by a search for institutional documents, including information and communications technology (ICT) documents, workshop upgrade schedules, and training schemes. Interview questions were used to extract information from all selected participants on how they are coping with and adapting to the changes brought about by technology in general, but by 4IR in particular, for the betterment of education in TVETs. The interviews lasted 30 minutes per participant and were conducted in a well-designed area with no disturbances. The researcher recorded the interviews using a voice recorder to keep the conversations as direct as possible and to ensure the credibility of the data. The interview did not affect teaching and learning because the researcher agreed with the participant to conduct it during the participant's non-teaching time.

Data Analysis

Braun and Clarke's (2006) guidelines informed the use of thematic analysis in this study. Initial coding, theme development, and case-by-case comparisons were conducted inductively, allowing themes to emerge naturally from participant data. The analysis was closely linked to concepts derived from Ecological Systems Theory (EST) and the Technological Pedagogical Content Knowledge (TPACK) framework.

Through this iterative process, the Technological Ecology Theory (TET) was developed, resulting in a final, embedded model representing the holistic structure of lecturer research. Using Braun and Clarke's (2006) approach, in-depth interviews were conducted with sixteen Mechanical Engineering lecturers from seven diverse TVET colleges. Transcripts were carefully coded, and through repeated reflection, themes capturing the complexities of lecturers' experiences and perceptions of AI technology integration emerged. This analytical process revealed patterns that emphasise the dynamic interaction between individual agency and institutional ecology, a dynamic that is central to the TET proposed in this study.

Ethical Considerations

Approval was sought from relevant institutions. Participation was voluntary, and confidentiality was maintained through the use of pseudonyms, secure recording, and anonymised institutional records. Furthermore, POPIA was discussed with the participants, and consent was agreed upon and signed.

Trustworthiness

Credibility was secured through member checking and extended engagement with the data. Dependability was ensured with an audit trail log for analytical decisions. Thick description supported transferability, and reflexive journaling contributed to confirmability.

Results and Discussion

Results

The themes below outline the findings:

Theme 1: Positive Attitudes Toward AI and Digital Simulations

Lecturers generally expressed enthusiasm about the potential of AI technologies to enhance their teaching practices.

Interest and Engagement

Lecturer A remarked:
"AI-powered experiments help students better visualise complex mechanical concepts that are otherwise challenging to demonstrate."

The same sentiments were echoed by lecturer G
Lecturer G shared:
"We see AI as a way to make lessons more interactive and tailored to student needs, which is very encouraging."

This enthusiasm indicates a high level of technical readiness and motivation among lecturers.

Theme 2: Institutional and Environmental Constraints

However, systemic limitations frequently impede the effective application of these technologies.

Resource and Equipment Limitations

Lecturer C:
"The condition of CNC machines and workshop tools is often poor, which seriously limits our ability to apply AI-based methods in practice."

Connectivity and Technical Support Issues

Lecturer M:
"Inconsistent internet and lack of dedicated technical staff make it hard to integrate AI tools consistently into our curriculum."

These constraints reflect an ecological environment that restricts technology uptake beyond individual lecturers' control.

Theme 3: Disconnect Between Lecturer Competence and Institutional Ecology

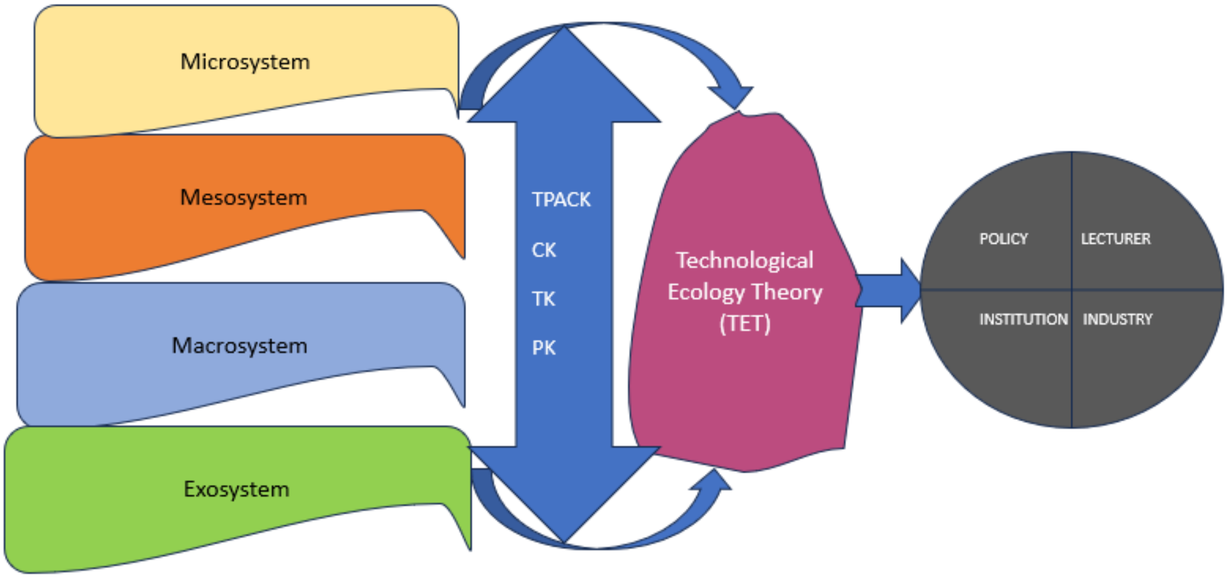
Multiple respondents highlighted the gap between their skills and the organisational environment needed to leverage AI effectively.

Lecturer J:
"We are well-versed in the software, but the broader system from infrastructure to administrative support does not currently enable us to use AI meaningfully in teaching."

This finding affirms the central role of systemic factors in technology integration, underscoring the relevance of a holistic model like TET.

The themes reveal a crucial insight: individual competence and positive attitudes exist alongside significant environmental barriers. The identified disconnect necessitates a systemic approach that acknowledges and addresses the broader ecological context of technology adoption. The TET framework offers this comprehensive perspective by emphasising the dynamic interplay between users, technology, and institutional factors in shaping human development within TVET colleges. Below is the Model of TET as it is introduced as a framework to understand the implications of AI in TVET colleges:

Theoretical Framework (TET Model)



Technological Ecology Theory Model

Figure 1: TET model by the author (Mhlanga P.T)

Ecological Systems Theory (EST)

Ecological Systems Theory is part of the development of the TET framework. Bronfenbrenner's Ecological Systems Theory (EST) views lecturer development not merely as a relational or individual process, but rather as taking shape within complex, interdependent, and nested systems that cumulatively impact technology adoption. The recurring pedagogical interactions among lecturers, students, and AI technologies, particularly the impact of AI-facilitated feedback cycles on educational decision-making, fall under the "process" category in this combined model. Lecturer attributes, such as the ability to adapt teaching and AI literacy, affect how deeply AI capabilities can be enacted. Context refers to institutional and infrastructural conditions within TVET colleges, including digital readiness, policy support, and resource availability, which mediate AI adoption and use. Time accounts for the developmental and recursive nature of AI integration, recognising that pedagogical adaptation and institutional learning evolve across implementation cycles.

The layers of EST Explained:
Microsystem: The immediate environment by which direct interactions happen, including the Mechanical Engineering lecturer's classroom, workshops, students, and the exact technologies used daily, including AI simulations, CNC software, and other discipline-specific digital tools.

Mesosystem: Interrelations between microsystems forming the microcosm that connects departmental colleagues, curriculum committees and workshop heads and contribute cohesively to defining teaching best practices, learning standards, and ways to share resources.

Exosystem: wider organisational environments that indirectly influence the lecturer's work, e.g., institutional infrastructure, management selection, ICT capability, industry involvement, partnerships, and partnerships with other business partners to allocate resources, which contribute to institutional priorities.

Macrosystem: The wider social, cultural, and policy context of the society of which the role is part, including national policies on a digital agenda, economic context, Fourth Industrial Revolution (4IR) projects, cultural attitudes about technology and in education.

Chronosystem: The chronosystem is the span of time that captures technological discoveries, institutional changes, and generational shifts, and influences changes in technology integration over time.

To illustrate how these layers are intricately intertwined, consider a national digital agenda from the Macrosystem perspective. This type of policy places strategic focus on digital transformation in the education sector, prioritises upgrading technological resources, and requires the integration of digital tools into the curriculum. These macro directives impact Exosystem by driving institutional leadership to strengthen ICT capacity, design skills-based professional development and drive industry partnership with digital objectives.

At the mesosystem level, these are institutional changes that affect departmental operations—curriculum committees updating curricula to reflect new technologies, and departmental heads assisting faculty in accessing relevant digital resources and training.

At the microsystem level, these changes also affect Mechanical Engineering lecturers, as they gain access to more technology and digital tools enabled by technological advancements that they need but are limited by their course requirements: up-to-date AI simulations and CNC programming interfaces that reflect present-day industry best practices.

Bronfenbrenner's EST framework helps explain how this national digital agenda, albeit at a macro level, cascades through nested systemic levels, shaping institutional contexts and interpersonal relationships before impacting technology use and instructional structures in the individual lecturer's practice. This nested, relational perspective helps highlight the complexity of technology adoption at the TVET level, where coordinated efforts across ecological levels are needed for meaningful integration.

TPACK in Ecological Systems

TET constructs TPACK within the ecological layers to demonstrate how CK, PK, and TK are shaped through the context and structure. A lecturer might have strong technical competence but be constrained by poor infrastructure, unreliable connectivity, or outdated equipment. TET situates TPACK within ecological systems, showing that lecturers' mastery of these spheres is not only individual but also shaped by systemic and structural determinants. The lecturer may be prompted to use AI, but if the internet connection is poor or the workshop equipment is outdated, their technological knowledge cannot be applied meaningfully.

Structural Development as a Factor that Matters

Building tools for structural development, such as fully equipped workshops, reliable internet connectivity, stable electricity, and accessible digital platforms, is vital for facilitating the performance of technology integration within Technical and Vocational Education and Training (TVET), particularly through the lens of Technological Pedagogical Content Knowledge (TPACK) embedded in ecological systems. Without sufficient structural preparedness, learning risks becoming predominantly theoretical, thereby limiting students' ability to translate knowledge into practical action. The educational environment's failure to offer authentic, technology-rich contexts deviates from the ideal ecological conditions that support situated learning and skill mastery (Fullan, 2013). This misalignment between the learning environment and industry expectations exacerbates the skills gap, the discrepancy between the competencies anticipated by employers and those delivered by TVET graduates (OECD, 2019).

The consequences of this disparity are substantial. A widening skills gap contributes directly to higher student unemployment rates, as graduates leave TVET programmes unprepared for the demands of the labour market (International Labour Organisation [ILO], 2020). From an ecological systems perspective, this outcome indicates a breakdown in the mesosystem interactions between educational institutions and industry sectors, underscoring the importance of ensuring that structural conditions within TVET institutions evolve in harmony with economic and technological trends (Bronfenbrenner, 1994). Thus, structural preparedness is not merely an academic concern but a critical issue for the economic survival of TVET graduates, highlighting the urgent need for strategic investments that align educational infrastructure with technological integration goals (Koehler, Mishra, & Cain, 2013).

By fostering an ecological environment conducive to the effective enactment of TPACK, TVET programmes can bridge the gap between theoretical understanding and practical application, ultimately enhancing graduate employability and contributing to sustainable workforce development.

TET Core Framework Introduction

Technological Ecology Theory (TET)

To address the structural limitations of the initial TET formulation, the framework explicitly takes a line in the PPCT mechanism, enabling a more systematic articulation of how artificial intelligence operates within TVET teaching ecologies.

Core Proposition

The adoption of AI technologies by lecturers in TVETs can best be viewed as an ecological developmental process in which structural conditions, the integration of knowledge, and systemic readiness play dynamic roles.

TET Model Components:

The TET model features these factors:

Technological Component: This dimension assesses the availability, accessibility, and usability of AI resources in the classroom and workshops according to TPACK as interpretability. It's about how teachers' use of technology affects pedagogy and student engagement.

Ecological Component: Directly taken from EST, this component examines communication across microsystems (education and individuals), mesosystems (departmental linkages and institutional support), exosystems (college institutions and ICT support), macrosystems (policies, socio-economic contexts), and chronosystems (changes in curriculum and technology development). It offers a perspective on investigating the role of environmental and institutional dimensions in the enactment of AI strategies in educational practice.

Teaching Component: This component focuses on educational practices, teachers' professional freedom, educational methods, and the inclusion of adaptive learning devices. It focuses on how teachers foster successful learning by integrating theoretical and practical knowledge into AI tools. The study thus illustrates that the role of AI methods is not merely a matter of lecturer competence, but rather a dynamic interplay among technology, pedagogical practices, and ecological contexts. The theoretical development of the conceptualisation advances the argument about TVET education by showing how ecology-based systems enable or limit AI uptake. In addition, the TET model has an adequate analytic horizon for further studies, which could help researchers and policymakers explore the systemic circumstances that affect adaptive teaching in vocational education. In this way, by linking the ecological perspective with technological learning, this research contributes, on its face, to a more nuanced understanding of how TVET lecturers implement their AI methodologies in difficult institutional and socio-technical settings.

TET integrates notions from knowledge frameworks (TPACK), Ecological Systems Theory (EST), and institutional structure theory to conceptualise technology adoption as an emergent, non-linear ecological development.

The theory hypothesises that:

- Strengthening the integrity and coherence of TPACK can be achieved by structurally improving existing conditions, which may result in quantifiable boosts of lecturers’ confidence and effectiveness in AI integration.

- This process can be falsified by observing cases in which the structural improvements do not lead to the development of stronger TPACK and higher AI adoption, thereby invalidating the theories or showing alternative processes.

Introducing the Technological Ecology Theory (TET) model, an expansion of EST and TPACK, the study offers a structured framework for a multi-level reflection of different factors that affect AI adoption in teaching.

Implications of TET

Policy: Policies related to digital transformation should focus on infrastructure investment, not just training programmes.

Institutions: Professional development and infrastructure should be integrated; they cannot work alone. *Lecturers*: TET helps lecturers view obstacles as ecological rather than individual failures.

Industry: Collaborations between industry and local actors may help close the institutionalised structural gap by co-investing in new training tooling that directly relates to the industrial revolution, thereby addressing the skills mismatch.

From an ecological systems perspective, artificial intelligence offers a qualitatively distinct set of affordances that transcend those of conventional educational technologies. Whereas conventional tools are mainly static or delivery-oriented, AI serves as a flexible enabler of the teaching & learning ecosystem, with real-time responsiveness to learner inputs, generative capabilities to design and improve teaching materials, and decision-support capabilities that support, rather than supplant, lecturer judgement. By offering these additional affordances, AI repositions its place in the educational ecology, facilitating interactions among lecturers, content, and learners in dynamic, context-sensitive ways.

Furthermore, the TET framework provides a range of theoretical predictions on AI applications in TVET contexts. It predicts a transition in lecturers' responsibilities from content transmitters of knowledge to learning designers and pedagogical orchestrators who influence teaching and learning, the increasing importance of data-informed instructional decision-making, and the development of AI-related pedagogical and technical capacity gaps among lecturers. It also foresees the potential for inequitable institutional preparedness to exacerbate pre-existing disparities in TVET colleges and supports more flexible and personalised teaching practices where infrastructural and professional support systems are sufficiently developed.

To address the limitations of linear cascade interpretations, the TET framework is reconceptualised as a dynamic ecological system characterised by bidirectional influence, feedback loops, and non-linear interactions across its constituent layers. Within this model, relationships between AI systems, lecturers, learners, and institutional contexts are not unidirectional but mutually constitutive, such that changes in one layer recursively reshape conditions in others. For example, AI-generated learning analytics influence lecturers' pedagogical decisions, while those decisions, in turn, generate new interactional data that modify subsequent AI outputs and institutional interpretations of teaching effectiveness. This establishes a continuous feedback loop between technological, pedagogical, and contextual subsystems.

Furthermore, the framework acknowledges the presence of threshold conditions, whereby incremental changes in AI adoption may produce disproportionate shifts in teaching practice once institutional readiness, lecturer competence, or infrastructural capacity reaches a critical tipping point. Conversely, below these thresholds, AI integration may remain superficial or symbolic rather than transformative. The model also explicitly defines system boundaries, situating the TET ecosystem within the TVET institutional environment while recognising external influences such as national policy regimes, labour market demands, and commercial AI platform architectures as exogenous but interacting systems.

Importantly, the framework incorporates systemic tensions and conflicts, recognising that alignment among AI affordances, pedagogical intentions, and institutional constraints is not guaranteed. In such cases, contradictions may emerge, for instance, where AI-driven efficiency metrics conflict with pedagogical goals of deep learning, or where infrastructural limitations constrain intended pedagogical innovation. These tensions are not treated as anomalies but as constitutive features of the system that may produce adaptation, resistance, or reconfiguration of practice over time.

Discussion

The relationship between Mechanical Engineering lecturers and AI technologies has been shown to be complex, according to the qualitative research arising from this study. Lecturers were interested in AI and digital simulations and held positive emotions toward them. However, uptake of the features mentioned below was more constrained by institutional barriers than by intrinsic resistance. In particular, the biggest gaps identified were unreliable or outdated workshop gear, inconsistent internet connectivity, and limited technical support. Such challenges highlight the importance of institutional contextual factors in technology adoption.

Despite this positive disposition, the actual integration of AI in teaching practice remains constrained by significant ecological limitations. The most prominent barriers identified include unreliable or outdated workshop equipment, inconsistent internet connectivity, and limited technical support. These constraints indicate that AI adoption in TVET colleges is not simply a matter of individual competence or willingness but is fundamentally shaped by the availability and stability of institutional support structures. In this sense, the findings align with an ecological interpretation of technology adoption, in which innovation is contingent upon multiple interacting system layers rather than on isolated individual agency.

Specific structural enablers (such as professional development, robust ICT infrastructure, and clear institutional policies) are key prerequisites that promote the integrated development of Technological Pedagogical Content Knowledge (TPACK). This coherent TPACK integration serves as a mediating variable, encouraging lecturers to embrace AI technologies with confidence and a purposeful stance in their teaching. In contrast, when these structural conditions are poor or incomplete, TPACK development is uneven or superficial, leading to inconsistent or slowed adoption of AI despite personal lecturers' positive intentions or efforts.

Conclusion

This study contributes to the development of a reconceptualised TET framework that positions artificial intelligence as an active ecological component within TVET teaching systems. The findings suggest that AI integration should not be understood as a linear enhancement of teaching practices but rather as a dynamic, interactive process shaped by feedback loops among lecturers, learners, institutional contexts, and technological systems. This perspective highlights the importance of recognising systemic tensions, contextual constraints, and adaptive thresholds that influence the effectiveness of AI-mediated pedagogy

Technological Ecology Theory offers a useful interpretation of lecturer development in technologically emerging TVET settings. To bridge ecological systems, pedagogical knowledge and structural realities, the model illuminates that technological reception becomes a systemic endeavour. It emphasises the significance of enabling environments, contemporary infrastructure and policies focused on the long-term integration of technology. The TET adds a holistic dimension to the understanding of human development in technology-oriented contexts and provides clear recommendations for strengthening TVET systems.

References

Akoojee, S. (2008). FET college lecturers: the 'devolving' link in the South African skills development equation. *Journal of Vocational Education & Training*, *60*(3), 297–313.

Aldridge, J. M., & McChesney, K. (2018). The relationships between school climate and adolescent mental health and wellbeing: A systematic literature review. *International Journal of Educational Research*, *88*, 121-145. https://doi.org/10.1016/j.ijer.2018.01.012

Brantley-Dias, L., & Ertmer, P. A. (2013). Goldilocks and TPACK: Is the construct 'just right?'. *Journal of Research on Technology in Education*, *46*(2), 103-128.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bronfenbrenner, U. (1979). *The ecology of human development*. Harvard University Press.

Bronfenbrenner, U. (1994). Ecological models of human development. In T. Husén & T. Postlethwaite (Eds.), *International encyclopedia of education* (Vol. 3). Elsevier.

Buthelezi, Z. (2018). Lecturer experiences of TVET College challenges in the post-apartheid era: a case of unintended consequences of educational reform in South Africa. *Journal of Vocational Education & Training*, *70*(3), 364–383. https://doi.org/10.1080/13636820.2018.1437062

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2016). A review of technological pedagogical content knowledge. *Educational Technology & Society, 19*(1), 61–73.

Czerniewicz, L., & Brown, C. (2014). The habitus and technological practices of rural students. *British Journal of Educational Technology*, *45*(1), 48–59.

Fullan, M. (2013). *The new meaning of educational change* (5th ed.). Teachers College Press.

Hennessy, S., Onguko, B., Harrison, D., Ang'ondi, E., Namalefe, S., Naseem, A., & Wamakote, L. (2018). *Developing the use of information and communication technology to enhance learning in East African schools: A review of projects and approaches*. Education Development Trust.

International Labour Organisation. (2020). *Global Employment Trends for Youth*. ILO Publishing.

Johnson, M. (2020). Teacher technology integration: A critical review of ecological influences. *Computers & Education, 149*, 103–116.

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge? *Journal of Education, 193*(3), 13–19. https://doi.org/10.1177/002205741319300303

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Ng'ambi, D., Brown, C., Bozalek, V., Gachago, D., & Wood, D. (2016). Technology enhanced teaching and learning in South African higher education–A rearview of a 20-year journey. *British Journal of Educational Technology*, *47*(5), 843-858. https://doi.org/10.1111/bjet.12485

Organisation for Economic Co-operation and Development. (2019). *Future of education and Skills for 2030: OECD learning compass report*. OECD Publishing.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK). *Journal of Research on Technology in Education, 42*(2), 123–149. https://doi.org/10.1080/15391523.2009.10782544

Wedekind, V., & Mutereko, S. (2021). Exploring the conditions of professional learning in TVET colleges. *Journal of Education, 83*, 1–24.