Digital Transformation and Student Engagement in Higher Education: An ICT and E-Learning Perspective

Malebo Suzan Mulaudzi

University of Johannesburg, Johannesburg Business School, South Africa

Abstract

The digital transformation of higher education has reshaped pedagogical practice and the conditions under which students engage with academic content. Despite substantial institutional investment in Information and Communication Technologies (ICT) and e-learning platforms, the literature has yet to produce a coherent account of how such investment translates into meaningful student engagement. This paper synthesises peer-reviewed scholarship on digital transformation, ICT adoption and e-learning quality to develop an integrated conceptual framework grounded in the Technology Acceptance Model (TAM), Constructivist Learning Theory (CLT) and the Student Engagement Framework (SEF). Drawing on a narrative and critical review of literature published between 2013 and 2026, the analysis examines how perceived usefulness, instructional design and institutional support converge to shape the behavioural, cognitive and emotional dimensions of engagement. The synthesis demonstrates that digital transformation enhances engagement only when ICT tools are accessible, pedagogically aligned and supported by digital readiness, leadership and inclusive design. Conversely, infrastructural deficits, weak instructional design, low digital literacy and persistent digital divides constrain engagement, particularly in South African and developing-country contexts. The framework positions student engagement as the central outcome of an enabled, mediated and pedagogically grounded transformation process. It offers theoretical, practical and policy guidance for advancing engagement-centred digital strategies in resource-constrained higher education settings.

Keywords: *Digital transformation; student engagement; ICT in education; e-learning quality; technology acceptance; South African higher education*

1. Introduction

Over the past decade, the integration of digital technologies into higher education has accelerated, repositioning ICT and e-learning platforms from peripheral instructional aids to central pillars of teaching, research and student services [1, 2, 3]. The COVID-19 pandemic acted as a forced accelerant of this trajectory, exposing both the latent capabilities and the structural fragilities of institutional digital infrastructures [4, 5]. Despite considerable investment, however, the relationship between digital transformation and student engagement remains insufficiently understood [6, 7]. Engagement, conceptualised across behavioural, cognitive and emotional dimensions, is widely regarded as a primary determinant of academic success [8, 9]. However, much of the existing scholarship examines transformation and engagement in isolation, focusing on specific tools or modalities without producing an integrated theoretical account [10, 11]. These limitations are amplified in the South African and broader developing-country context, where transformation imperatives intersect with persistent digital inequality, infrastructural constraints and the Fourth Industrial Revolution agenda [12, 13].

The existing literature exhibits three interrelated weaknesses. First, it remains fragmented: perceived usefulness, system quality, digital readiness and instructional design are typically examined in isolation rather than as a coherent multi-level account of how transformation reaches students [6]. Second, the behavioural, cognitive and emotional dimensions of engagement are seldom addressed simultaneously, with observable participation privileged in empirical work while deeper cognitive investment and emotional connection remain under-theorised [9, 17]. Third, much scholarship rests on infrastructural and cultural assumptions that do not transfer cleanly to South African and developing-country settings, where digital divides and infrastructural gaps remain constitutive of the transformation process [12, 18]. Against this backdrop, this study synthesises secondary literature to develop an integrated conceptual framework grounded in TAM, CLT and SEF, designed both to clarify how digital transformation shapes engagement and to extend the theoretical repertoire for analysing transformation in resource-constrained settings. Three objectives guide the analysis: to synthesise published scholarship on digital transformation, ICT adoption, and e-learning quality in higher education; to examine how ICT tools and e-learning quality shape the behavioural, cognitive, and emotional dimensions of student engagement; and to integrate TAM, CLT, and SEF into a unified conceptual model. The remainder of the paper presents the

literature review (Section 2), the research methodology (Section 3), the findings (Section 4), the proposed conceptual framework (Section 5), the discussion (Section 6), the study's contribution (Section 7), and the conclusion (Section 8).

2. Review of Related Literature

The literature review is organised thematically to support the conceptual framework presented in Section 5. Three thematic clusters are examined: digital transformation in higher education, ICT adoption and e-learning quality, and the dimensions of student engagement, each interrogated for the patterns on which the literature converges, the contradictions it sustains and the gaps it leaves unresolved. A concluding subsection integrates the three theoretical resources whose convergence yields the framework.

2.1 Digital Transformation in Higher Education

Recent scholarship reframes digital transformation away from tool deployment and towards a comprehensive reconfiguration of teaching, learning, research, and administrative practice [6, 19]. [14] argues that present concerns centre on organisational change, leadership, faculty experience, and inclusive strategy rather than on technology procurement alone, with digital leadership recurring as a particularly consequential capability that mediates resource allocation, faculty support, and digital culture [20, 22]. The literature remains divided, however, on the experiential consequences of transformation. One stream emphasises its productive and emancipatory potential [3, 4]; another foregrounds its costs, administrative burden, digital fatigue, faculty resistance and inequities in competence and access [23, 24]. The contradiction is one of emphasis rather than fact: the same processes generate both effects, with the relative weighting determined by the institutional substrate in which they unfold. A persistent gap persists: frameworks developed in well-resourced settings transfer poorly to South African and other developing-country contexts unless they explicitly address structural deficits in connectivity, devices, and digital literacy [13, 18]. This body of work motivates Tier 1 of the proposed framework, in which institutional digital transformation is captured as a strategic, infrastructural and cultural reconfiguration.

2.2 ICT Adoption and E-Learning Quality

If institutional transformation establishes the strategic backdrop, ICT adoption and e-learning quality constitute the technical-pedagogical mechanism through which transformation reaches students. A consistent pattern in the adoption literature identifies perceived usefulness, perceived ease of use, institutional support, infrastructural reliability and content quality as core determinants [26]. E-learning quality, operationalised through usability, content relevance, interactivity, and technical reliability, has likewise been identified as a critical determinant of satisfaction and learning outcomes [16, 27, 28], with the pattern holding across institutional types, national settings, and the most recent generation of adaptive, AI-driven, and immersive systems [29]. The literature presents a sharp contradiction, however, over whether technical quality is, in itself, sufficient. Tool-specific findings frequently fail to generalise, and a substantial body of evidence demonstrates that ICT-mediated pedagogy produces engagement gains only when integrated with disciplined teaching practice [32]. Chaturvedi et al. [34] show that effective deployment, rather than infrastructure alone, distinguishes outcomes, a finding at odds with tool-deployment narratives that treat platform quality as the dominant variable. The conceptual bridge between adoption decisions and learning engagement remains thinly developed: TAM-style accounts explain user perceptions but not how adoption translates into pedagogical conditions [35], while constructivist accounts specify those conditions but offer little guidance on adoption antecedents. This literature motivates Tier 2 of the framework, perceived usefulness, ease of use, usability, interactivity and content quality, and justifies the claim that Tier 2 is necessary but not sufficient and must be coupled with Tier 3 mediating factors.

2.3 Student Engagement Dimensions

The tripartite conceptualisation of engagement, behavioural, cognitive and emotional, has achieved near-universal adoption in the digital learning literature [8, 37]. Behavioural engagement encompasses participation, task completion and observable interaction; cognitive engagement refers to depth of intellectual investment, metacognitive strategy use and active knowledge construction; emotional engagement captures motivation, interest and a sense of belonging. The construct's analytic robustness is substantiated by Bond et al.'s [8] systematic mapping of 243 studies. The literature, however, sustains a sharp contradiction over the relationship

among the three dimensions. One stream treats engagement as additive, assuming that interventions targeting any single dimension contribute to overall engagement [38, 39]. A second demonstrates that the dimensions are configurational rather than additive: tools driving behavioural participation may simultaneously displace the cognitive depth they were intended to enable [15], and behavioural metrics frequently fail to predict learning achievement, which depends on the configurational pattern of cognitive and emotional engagement [40]. [8] further show that behavioural engagement is the most frequently observed dimension and cognitive engagement the least often theorised, skewing the empirical base toward easily measured rather than consequential variables. Recent work maps differential responsiveness: emotional engagement is tied to inclusive design, social presence and culturally responsive pedagogy [43]; cognitive engagement is most sensitive to instructional design and constructivist alignment [37]; and behavioural engagement responds most directly to access and ease of use [42]. This literature motivates Tier 4 of the framework.

2.4 Theoretical Integration

Three theoretical resources jointly yield the framework. TAM, refined in recent applications to augmented reality and emotion-augmented engagement, explains the perceptual antecedents of adoption at Tier 2 [35, 36]. Constructivist Learning Theory, applied by [44] through socio-constructivist and ecological lenses, specifies the pedagogical conditions under which adoption deepens into cognitive engagement at Tier 4. The Student Engagement Framework provides the analytic taxonomy through which Tier 4 outcomes are observed [9]. TAM accounts for perception-level antecedents, CLT for pedagogical conditions and SEF for outcome taxonomy; the mediating layer at Tier 3 is where these resources jointly do their explanatory work.

3. Research Methodology

This study employs a conceptual research design grounded in a narrative and critical review of secondary literature. The design is appropriate to the study's objective of developing a framework rather than testing an a priori model against new empirical data. The narrative–critical review tradition is well established in higher education research as a vehicle for theoretical integration across heterogeneous empirical contexts. No primary data were collected, and no human participants were involved. Sources comprised peer-reviewed journal articles, edited book chapters and conference proceedings published between 2013 and 2026, retrieved from five databases: Scopus, Web of Science, EBSCOhost, ScienceDirect and Google Scholar. The 2013–2026 window captures contemporary digital transformation literature, including pre- and post-pandemic discourse on online and blended learning. Search terms combined three conceptual clusters digital transformation ('digital transformation higher education', 'digitalisation higher education', 'ICT in higher education'); adoption and quality ('technology acceptance model higher education', 'e-learning system quality'); and engagement ('student engagement digital learning', 'behavioural cognitive emotional engagement') with contextual terms such as 'South Africa', 'developing country' and 'digital divide higher education' to surface scholarship relevant to the study's regional focus. Inclusion criteria specified English-language peer-reviewed sources within the date range with a substantive focus on digital transformation, ICT adoption, e-learning quality, student engagement or technology acceptance in higher education; sources were retained where they addressed one of the three theoretical lenses or contributed empirical evidence on enabling and constraining factors. Editorials, blog posts, non-peer-reviewed grey literature, sources focused exclusively on school-level or corporate training contexts and duplicate records were excluded. The final corpus comprised 48 sources.

Analysis proceeded in three stages. The first was thematic coding: each source was coded against the three thematic clusters, and recurring patterns, theoretical claims and contradictions were identified [7, 14]. The second was theoretical mapping: each thematic cluster was related to TAM, CLT, and SEF to identify which lens did the explanatory work at each point. Convergences and divergences were used to specify the conditions under which competing claims hold, rather than to reconcile them artificially. The third was framework construction: the theoretical mapping was integrated with structural patterns from the thematic coding to produce a multi-tier framework. The framework was validated through three internal checks consistency with each theoretical lens, capacity to accommodate empirical patterns and contradictions, and applicability to South African and developing-country contexts. Three design limitations should be acknowledged: the framework is constructed from secondary literature rather than tested against primary data; the English-language inclusion criterion may have excluded relevant Francophone and Lusophone African scholarship; and the privileging of peer-reviewed sources may underrepresent practitioner knowledge.

4. Findings

The secondary data synthesis identified four interrelated themes between digital transformation and student engagement.

Theme 1: Digital transformation is multi-dimensional, and its experiential consequences are contested

Across the corpus, digital transformation is consistently reframed as a comprehensive reconfiguration of teaching, learning, research and administrative practice rather than a tool-deployment exercise [1, 6, 19]. The literature, however, is divided over the experiential consequences of that reconfiguration. One stream documents its productive and emancipatory potential [3, 4]; another documents its costs, administrative burden, digital fatigue, faculty resistance and inequities in competence and access [23, 24]. The two streams are not factually inconsistent: the same processes generate productive and costly effects simultaneously, with the institutional substrate (strategy, leadership, infrastructure and culture) determining which effect dominates in a given setting. Two propositions follow. First, accounts presenting transformation as uniformly progressive overstate the evidence. Second, the institutional and cultural conditions under which transformation is implemented are themselves part of the explanation for engagement outcomes, not preconditions to be assumed.

Theme 2: ICT adoption and e-learning quality are necessary but not sufficient for engagement

The adoption literature consistently identifies a core set of determinants shaping ICT uptake and e-learning quality: perceived usefulness, perceived ease of use, institutional support, infrastructural reliability, content quality, usability and interactivity [4, 25–28, 32]. The pattern holds across institutional types, national settings and the most recent generation of adaptive, AI-driven and immersive systems [29–31]. The same literature equally consistently demonstrates that the presence of these determinants is necessary but not sufficient. [34] show that effective pedagogical deployment, rather than infrastructure alone, distinguishes outcomes; [33] shows interactive tools yield stronger results when they enable active rather than passive engagement; [26] shows ICT-mediated pedagogy produces engagement gains only when integrated with disciplined teaching practice. Technical and adoption-level conditions establish the possibility of engagement but do not produce it; translation depends on the pedagogical and institutional mediating layer linking Tier 2 to Tier 4.

Theme 3: Student engagement is configurational rather than additive across its three dimensions

The tripartite conceptualisation of engagement [8, 9, 37] is near-universally adopted, but the relationships among the three dimensions are contested. One stream treats engagement as additive, assuming interventions targeting any single dimension contribute to overall engagement [38, 39]. A second stream demonstrates that the dimensions are configurational rather than additive: tools driving behavioural participation may displace the cognitive depth they were intended to enable [15, 17], and behavioural metrics frequently fail to predict learning achievement, which depends on the configurational pattern of cognitive and emotional engagement [40]. [8] show that behavioural engagement is the most frequently observed dimension and cognitive engagement the least theorised, skewing the empirical base toward easily measured rather than consequential variables. Differential responsiveness is therefore both empirically warranted and analytically necessary: behavioural engagement responds most directly to access and ease of use; cognitive engagement is most sensitive to instructional design and constructivist alignment; emotional engagement is most responsive to inclusive design, social presence and culturally responsive pedagogy [37, 41, 42, 43].

Theme 4: Constraining factors are systematically more salient in South African and developing-country contexts

The mediating layer of enablers and constraints behaves asymmetrically across contexts. In well-resourced settings, enabling factors such as digital readiness, instructional design quality, institutional support, digital leadership, faculty digital competence and inclusive design dominate analytical attention [20, 22, 44]. In South African and developing-country settings, constraining factors, such as digital divides, infrastructural deficits, low digital literacy, faculty resistance, weak strategic alignment and gendered patterns of access, are systematically more salient and persistently shape engagement outcomes [12, 13, 18, 46]. Enablers are not absent in such

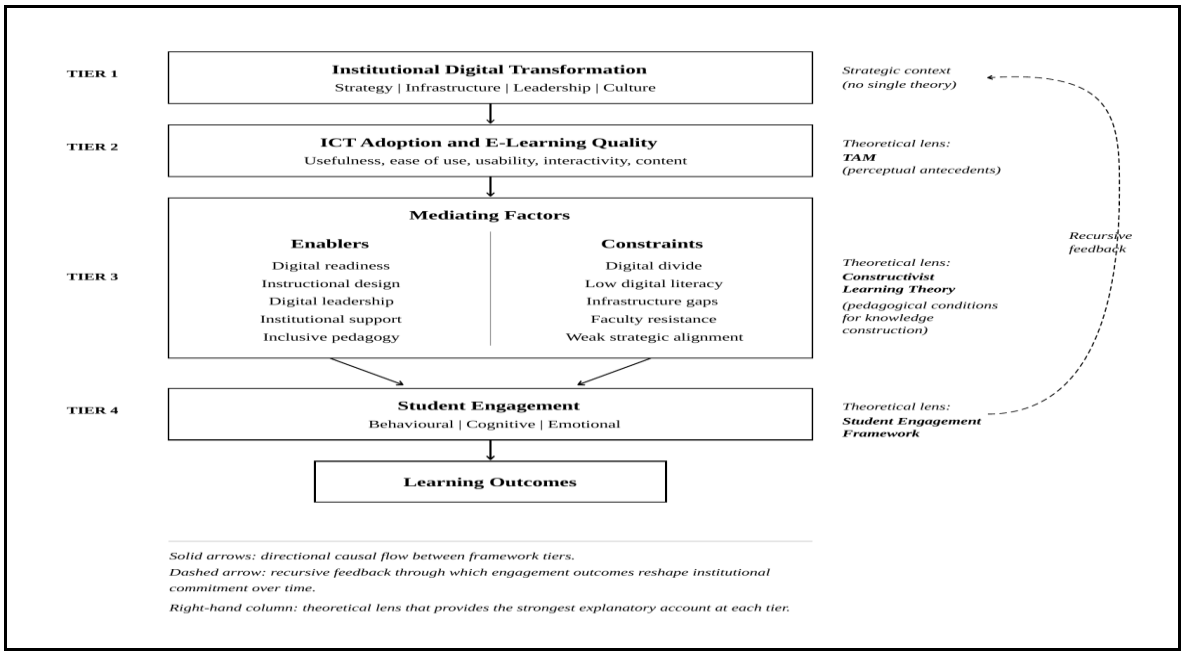
settings; rather, the gradient of constraint is steeper, and frameworks developed in well-resourced contexts cannot be transposed unmodified without distorting empirical reality. This asymmetry is the empirical basis for the framework's decision to treat constraining factors as constitutive of Tier 3 rather than as residual noise.

5. The Proposed Conceptual Framework

Drawing on the four findings, this section presents the integrated conceptual framework, the study's principal output. The framework positions student engagement as the central outcome of a multi-level, theoretically integrated digital transformation process comprising four interrelated tiers: institutional digital transformation as the strategic driver (Tier 1); ICT adoption and e-learning quality as the technical-pedagogical mechanism (Tier 2); mediating, enabling and constraining factors (Tier 3); and student engagement in its behavioural, cognitive and emotional forms as the principal outcome (Tier 4).

Tier 1 captures the strategic, infrastructural, and cultural reconfiguration through which institutions pursue digitally enabled missions, invest in infrastructure, formulate a digital strategy, establish digital leadership, and embed digital culture [1, 2, 20]. Without institutional-level commitment, lower-level investments remain disconnected from a coherent architecture and fail to produce systemic change. Tier 2 operationalises the mechanism through which transformation reaches students: ICT adoption depends on the central TAM variables of perceived usefulness, perceived ease of use and institutional support, while e-learning quality captures usability, content relevance, interactivity and pedagogical alignment with constructivist principles [28, 32, 35]. Tier 3 captures the mediating layer through which adoption translates into engagement. Enabling factors include digital readiness, instructional design quality, institutional support, digital leadership, faculty digital competence and inclusive design [22, 41, 44]; constraining factors include digital divides, infrastructural deficits, low digital literacy, faculty resistance and weak strategic alignment [14, 18, 23]. In the South African and developing-country context, constraining factors are systematically more salient and demand explicit institutional and policy response [12, 13]. Tier 4 operationalises the outcome through the tripartite framework of behavioural, cognitive and emotional engagement, with each dimension differentially activated: behavioural engagement by access, ease of use and infrastructural reliability; cognitive engagement by instructional design quality and constructivist alignment; and emotional engagement by inclusive design, social presence and culturally responsive pedagogy [8, 36]. Relationships among the tiers are recursive rather than unidirectional: strong engagement outcomes feed back into institutional commitment, while weak outcomes erode it [8, 23]. Through this recursive dynamic, transformation and engagement co-evolve over time.

Figure 1 illustrate the proposed conceptual framework for digital transformation and student engagement in higher education.



Source: Researcher's own Compilation

Figure 1 presents the framework as a four-tier vertical cascade together with the theoretical mapping that underwrites it. The right-hand column identifies the lens that does explanatory work at each tier: the Technology Acceptance Model accounts for the perceptual antecedents of adoption at Tier 2; Constructivist Learning Theory accounts for the pedagogical conditions at Tier 3 under which adoption deepens into knowledge construction; and the Student Engagement Framework accounts for the tripartite engagement outcomes at Tier 4. No single theory governs tier 1 but provides the strategic context within which the lower tiers operate. Three structural features warrant emphasis. The first is the partitioning of the mediating layer into enablers and constraints, which signals that institutions cannot pursue one without managing the other; in resource-constrained settings, this symmetry is particularly consequential. The second is the convergence of two arrows from the mediating layer onto Tier 4, which encodes the analytical claim that engagement is the joint product of supportive and constraining conditions rather than the linear output of supply-side investment alone. The third is the dashed recursive feedback arrow from Tier 4 to Tier 1, which converts the framework from a static taxonomy into a dynamic system: engagement outcomes do not merely register the effects of transformation but, over time, reshape the institutional commitment, leadership choices, and digital culture that drive subsequent transformation cycles. The figure thereby visualises the central theoretical contribution of the study: the consolidation of three previously parallel literatures into a single, integrated, multi-level account of how digital transformation produces, or fails to produce, student engagement in higher education.

6. Discussion

The four findings and the framework carry implications that extend beyond the analytical claims themselves. Four interpretive moves are made. First, the dominant policy logic of digital transformation globally and in South Africa treats infrastructure investment and platform adoption as the principal levers for lifting engagement [2, 14]. Finding 2 directly contests this logic: technical conditions establish possibility but not outcome. Recent work [15] argues that supporting engagement in technology-enhanced learning requires attending to pedagogical, relational and institutional conditions. The framework's mediating layer is the analytical correction. Institutional and policy interventions that bypass Tier 3 instructional design, digital readiness, faculty competence and inclusive design should be expected to underperform regardless of the scale of Tier 1 and Tier 2 investments. Second, the configurational character of engagement has implications for institutional evaluation practice. If the three engagement dimensions are differentially activated and may move in opposition, the prevailing reliance on behavioural metrics, such as login frequency, time on platform, post counts, and completion rates, produces an evaluation system biased toward the most easily measured but least consequential dimension. [17] and [40] provide direct empirical support for this concern. Institutions evaluating digital transformation strategies on engagement grounds will need instruments that capture cognitive depth and emotional connection alongside observable participation, with policy-level monitoring expanded commensurately.

Third, the salience of constraining factors in South African and developing-country settings is more than additional difficulty within a shared theoretical landscape. The asymmetry calls into question the implicit universalism of much global digital transformation literature, which has been disproportionately produced in well-resourced settings [2, 44]. The framework's treatment of constraining factors as constitutive of Tier 3 rather than residual noise is therefore both an empirical accommodation and a theoretical claim: structural conditions are part of the explanation of engagement, not an external scope condition. This has direct implications for how comparative higher education research is designed and how policy borrowing across contexts is justified. Fourth, the rapidly evolving technological frontier introduces new tensions. [30] and [31] demonstrate gains in engagement from AI-integrated platforms, yet [47] caution that over-reliance on AI may diminish critical thinking and authentic engagement. Within the framework, these technologies sit at Tier 2 but alter the conditions of the Tier 3 mediating layer: adaptive platforms partially substitute for instructional design effort, intelligent tutoring for instructor presence, and immersive environments potentially reshape the constructivist conditions of knowledge construction. The framework anticipates that the evaluative challenge identified in Theme 3, the asymmetric measurement of the three engagement dimensions, will intensify rather than diminish as these technologies mature, since AI-driven systems generate behavioural signals at unprecedented volume while leaving cognitive and emotional substrates harder to access.

7. Contribution of the Study

The study's primary theoretical contribution lies in developing an integrated framework that synthesises TAM, CLT and SEF into a coherent account of the relationship between digital transformation and student engagement. The framework addresses the fragmentation of the existing literature, in which these three resources have typically been deployed in isolation, and extends prior conceptualisations by incorporating mediating factors and treating the relationship as recursive rather than unidirectional. By foregrounding the South African and developing-country context, it also responds to recent calls to move beyond global-North paradigms in higher education research [2, 44]. For institutions, curriculum developers and e-learning designers, the framework provides evidence-based guidance for structuring digital learning environments that genuinely enhance engagement. It identifies the enabling conditions of digital readiness, instructional design quality, institutional support, accessible infrastructure, digital leadership and inclusive pedagogy that must be present for transformation to translate into engagement gains, alongside the constraining conditions that must be actively managed. Strategically, transformation should be planned as a coordinated programme integrating infrastructure, pedagogy, leadership development and inclusion; evaluatively, institutions should monitor engagement across all three dimensions rather than relying solely on participation metrics. For policymakers in the South African higher education sector, the framework supports three directions: investment in the mediating layers of digital readiness, instructional design, faculty development, digital leadership and inclusive pedagogy alongside infrastructure; embedding inclusive design as a foundational policy requirement given the structural inequalities and constitutional equity commitments that distinguish the South African context; and expanding policy-level monitoring beyond access and adoption metrics to capture engagement outcomes across the behavioural, cognitive and emotional dimensions [45].

8. Conclusion

This study has synthesised secondary literature on digital transformation, ICT adoption, and e-learning quality, and developed an integrated conceptual framework grounded in TAM, CLT, and SEF. The framework positions student engagement, in its behavioural, cognitive and emotional dimensions, as the central outcome of a multi-level transformation process mediated by enabling and constraining factors that are particularly salient in South African and developing-country contexts. Three principal conclusions follow. First, digital transformation enhances engagement only when ICT tools are accessible, pedagogically aligned and supported by institutional readiness, leadership and inclusive design. Second, the dimensions of engagement are differentially responsive to elements of the transformation process and therefore require coordinated intervention across infrastructural, pedagogical and cultural levels rather than concentration at a single point. Third, the South African context calls for strategies that simultaneously expand access, address infrastructural inequality, build digital literacy and embed inclusion as a foundational rather than peripheral concern. Future empirical work should validate the framework in South African higher education settings, extend it to comparable developing-country contexts and examine the consequences of emerging AI-driven, immersive and adaptive technologies for engagement.

REFERENCES

[1] Alenezi, M. (2021). Deep dive into digital transformation in higher education institutions. Education Sciences, 11(12).
[2] Mhlanga, D. (2023). The fundamental strategies that will drive the higher educational sector towards digital transformation in Industry 4.0. Emerging Science Journal, 7(Special issue 2), 125–134.
[3] Sangotra, D. I., Vasundhara, S., et al. (2025). Digital innovation in the higher educational system: Application of information and communication technology. In AI-powered educational games and simulations (pp. 367–389). IGI Global.
[4] Adtani, R., Neelam, N., et al. (2025). Embracing ICT in academia: Adopting and adapting to the new normal pedagogy. Global Knowledge, Memory and Communication, 74(3–4), 806–823.
[5] Al-Ansi, A. M., & Fatmawati, I. (2023). Integration of ICT in higher education during the COVID-19 pandemic: A case study. International Journal of Learning and Change, 15(4), 430–442.
[6] Halkhoree, R., Santally, M. I., et al. (2024). A review of the digital transformation landscape in higher education institutions. In the 1st International Conference on Smart Energy Systems and Artificial Intelligence (SESAI 2024). IEEE.
[7] Rahmadi, I. F. (2024). Research on digital transformation in higher education: Present concerns and future endeavours. TechTrends, 68(4), 647–660.

[8] Bond, M., Buntins, K., et al. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. International Journal of Educational Technology in Higher Education, 17(1).
[9] ElSayary, A., Mohebi, L., et al. (2022). The impact of the relationship among social/emotional, cognitive, and behavioural engagements on the development of preservice teachers' digital competencies. Journal of Information Technology Education: Research, 21, 269–295.
[10] Muhammad, A. S., Nat, M., et al. (2025). Exploring the horizon: A comprehensive systematic literature review on student engagement in the metaverse. On the Horizon, 33(2), 223–244.
[11] Vasudevan, A., Mohammad, R., et al. (2026). Trends and patterns in e-learning research: A bibliometric study on university student engagement. In Studies in Systems, Decision and Control (Vol. 645, pp. 203–214). Springer.
[12] Kafile, M., Ninana, N., et al. (2025). The digital divide and e-learning participation: A mixed-methods study of Extended Curriculum Programme students in South Africa. International Journal of Learning, Teaching and Educational Research, 24(9), 769–784.
[13] Nkosi, N., & Maphalala, M. C. (2026). Bridging the gendered digital divide: Strategies for enhancing access and inclusion for students in higher education. Gender Issues, 43(1).
[14] Singun, A. J. (2025). Unveiling the barriers to digital transformation in higher education institutions: A systematic literature review. Discover Education, 4(1).
[15] Rotar, O. (2025). Beyond technology tools: Supporting student engagement in technology-enhanced learning. Education Sciences, 15(12).
[16] Shah, R. K., & Barkas, L. A. (2018). Analysing the impact of e-learning technology on students' engagement, attendance and performance. Research in Learning Technology, 26.
[17] Liu, Z., Tang, Q., et al. (2024). Profiling students' learning engagement in MOOC discussions to identify learning achievement: An automated configurational approach. Computers and Education, 219.
[18] Aziz, M. A., Ayob, A. H., et al. (2026). Strategies for overcoming the digital divide in higher education institutions: A systematic literature review. Education Policy Analysis Archives, 34.
[19] Ramalakshmi, K., Devi, R., et al. (2026). Digital transformation and technology in higher education. In Driving institutional excellence through accreditation standards in higher education (pp. 181–202). IGI Global.
[20] Arham, A. F., Norizan, N. S., et al. (2024). Enhancing academic performance: Investigating the nexus between digital leadership and the role of digital culture. Bottom Line, 37(3), 253–276.
[21] Khurniawan, A. W., & Supriadi, D. (2024). The impact of digital leadership on digital transformation in university organisations: An analysis of students' views. Perspektivy Nauki i Obrazovania, 67(1), 677–690.
[22] Liao, S., & Ismail, A. B. (2025). The impact of digital leadership on the ICT competence of Chinese university teachers: Organizational commitment as a mediating variable. International Research Journal of Multidisciplinary Scope, 6(4), 487–507.
[23] Deacon, B., Laufer, M., et al. (2025). Resisting digital change at the university: An exploration into triggers and organisational countermeasures. European Journal of Higher Education, 15(sup1), 119–142.
[24] Dogan, M., & Arslan, H. (2026). Empowering academics in the digital age: Navigating the transformation of higher education. European Journal of Education, 61(1).
[25] Al-araibi, A. A. M., Naz'ri bin Mahrin, M., et al. (2019). A model for technological aspect of e-learning readiness in higher education. Education and Information Technologies, 24(2), 1395–1431.
[26] Kumar, S. (2024). The effects of information and communication technology (ICT) on pedagogy and student learning outcome in higher education. EAI Endorsed Transactions on Scalable Information Systems, 11(2), 1–5.
[27] Khrisat, Z., & Fakhouri, H. N. (2024). Impact of e-learning tools (Moodle, Microsoft Teams, Zoom) on student engagement and achievement at Jordan universities. International Journal of Interactive Mobile Technologies, 18(18), 125–145.
[28] Seraj, A. H. A., & Sundram, V. P. K. (2025). Perceptions of e-learning effectiveness: A cross-sectional study of e-learning portal users in higher education. Revista Electronica de LEEME, (56), 153–171.
[29] Naseer, F., Khan, M., et al. (2024). Integrating deep learning techniques for personalized learning pathways in higher education. Heliyon, 10(11).
[30] Yermaganbetova, M., Ashimbekova, A., et al. (2026). Evaluating the impact of an AI-integrated learning platform on student performance: A quasi-experimental study. Frontiers in Education, 11.
[31] Zhou, C., Ren, Z., et al. (2025). The impact of AI-based adaptive learning technologies on motivation and engagement of higher education students. Education and Information Technologies, 30(16), 22735–22752.
[32] Carabregu-Vokshi, M., Ogruk-Maz, G., et al. (2024). 21st century digital skills of higher education students during COVID-19: Is it possible to enhance digital skills of higher education students through e-learning? Education and Information Technologies, 29(1), 103–137.

[33] Yao, Z. (2025). Exploring the impact of interactive digital tools on learning outcomes in higher education. International Journal of Inclusive Education.
[34] Chaturvedi, K. K., Bisaria, G., et al. (2025). The role of information and communication technology in enhancing teaching-learning outcomes: A comparative analysis of government and private colleges in Uttar Pradesh. International Review of Management and Marketing, 15(6), 475–481.
[35] Matin, F., & Mangina, E. (2025). Exploring students' acceptance of augmented reality technologies in education: An extended Technology Acceptance Model approach. In Lecture Notes in Computer Science. Springer.
[36] My, P. D., Yen, T. T. H., et al. (2026). The role of emotional experience in student engagement on e-learning platforms: An extended Technology Acceptance Model. In Lecture Notes in Networks and Systems. Springer.
[37] Hasnan, H. N., Norman, H., et al. (2026). Enhancing pedagogical design through students' engagement in augmented reality learning: Evidence from a validated cognitive–affective framework. International Journal of Learning, Teaching and Educational Research, 25(1), 434–455.
[38] Aldaihani, F. M. F. (2023). From physical to virtual: The impact of mixed reality technologies on students' engagement in Kuwait universities using structural equation modeling. International Journal of Data and Network Science, 7(2), 523–532.
[39] Hakobyan, L., Lee, M., et al. (2025). Virtual tools and student engagement: Insights from engineering education. In IEEE Global Engineering Education Conference (EDUCON). IEEE Computer Society.
[40] Erandika, L., Wijayanayake, J., et al. (2024). Analyzing the impact of student engagement on learning outcomes in e-learning platforms: Case on programming language courses. In Proceedings – International Research Conference on Smart Computing and Systems Engineering (SCSE 2024). IEEE.
[41] Hashmi, R. (2026). Culturally responsive digital pedagogy: Addressing inclusivity and accessibility in online learning platforms. In Designing better digital learning environments: Approaches and insights (pp. 441–470). IGI Global.
[42] Sangsuwan, W., Saithong, T., et al. (2026). Evaluating digital solutions for inclusive and engaging higher education. TEM Journal, 15(1), 744–756.
[43] Soriano, K. T., Inga-Avila, M., et al. (2025). Impact of intelligent tutoring on emotion and academic performance of systems engineering students at the National University of Central Peru. International Journal of Data and Network Science, 9(2), 289–296.
[44] Antwi-Boampong, A., Ujakpa, M. M., et al. (2025). Learning in context: Faculty adoption of blended learning through socio-constructivist and ecological lenses. Open Praxis, 17(4), 803–820.
[45] Morales-Arevalo, J. C., Medina-La_plata, E., et al. (2025). Strategic framework for inclusive and sustainable digital transformation in University 5.0. International Journal of Information and Education Technology, 15(12), 2730–2740.
[46] Vergara, D., del Bosque, A., et al. (2026). Bridging the digital divide among higher education faculty: The role of university type and faculty ICT expertise. Education Sciences, 16(4).
[47] Abubakar, S., Jeilani, A., et al. (2025). The role of over-reliance on AI in the negative consequences of student learning: The moderating effects of ethical concerns and institutional policies. Cogent Education, 12(1).
[48] Leong, W. Y. (2025). Designing for diversity: Creating inclusive digital learning environments for global classrooms. Engineering Proceedings, 103(1).