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Design science for digital literacy: an equity-sensitive framework for learning management system integration in resource-constrained universities

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Digital literacy is central to student success in technology-mediated higher education, particularly in resource-constrained environments. This study introduces the Digital Literacy Course for Learning Management Systems (DLC4LMS), an equity-sensitive instructional design framework that synthesises the ASSURE model, Universal Design for Learning (UDL), Community of Inquiry (CoI), EquityXDesign, and Laurillard's Conversational Framework. Guided by Design Science Research (DSR), the study followed three iterative cycles: (1) relevance, identifying digital literacy gaps among first-year students; (2) design and development, constructing the DLC4LMS framework through theoretical integration and stakeholder input; and (3) rigour and evaluation, formatively validating the framework with academic staff at two South African universities. Findings suggest the importance of embedding equity as a design driver, integrating mobile-first tools, and linking digital literacy to both academic survival and employability. The DLC4LMS extends existing instructional design models, traditionally developed in well-resourced contexts. By adapting them for low-bandwidth, mobile-only, and equity-challenged universities. While developed in South Africa, its principles are transferable to similar Global South and humanitarian education settings. This research contributes a theoretically grounded, context-responsive model that advances inclusive digital transformation in higher education.

KEYWORDS

design science, digital literacy, equity-sensitive design, global south, higher education, learning management systems

1 Introduction

Digital literacy is widely recognised as the ability to effectively perceive, evaluate, and utilise digital technologies (Falloon, 2020). Jones and Hafner (2021) extend this definition to encompass a broad spectrum of competencies, including the use of digital platforms, online communication, critical evaluation of online content, and ensuring digital safety and privacy. As digital technologies continue to shape various sectors, including higher education institutions, the development of digital literacy has become increasingly vital for South African universities (Spante et al., 2018). Therefore, implementation of digital literacy courses specifically tailored to the needs of students from previously disadvantaged universities has become vital, aiming

to bridge technological gaps and promote academic equity. To effectively address the challenges faced by underprivileged students, digital literacy initiatives must consider their unique socioeconomic backgrounds and offer comprehensive, accessible instruction (Reyna et al., 2018). Embedding digital literacy as either a credit or non-credit course could enhance student engagement and academic success by offering targeted support and resources (Adekugbe and Ibeh, 2024).

A course centred on LMS could yield significant benefits by equipping both students and educators with essential navigation and usage skills (Bradley, 2021). Such a course would assist students in accessing course materials, engaging with content, submitting assessments, and participating in discussions, thereby promoting meaningful academic interaction. However, in the South African context, universities situated near rural and underdeveloped areas predominantly serve students from disadvantaged backgrounds who often lack prior exposure to digital technologies (Matli and Ngoepe, 2022). These students face multiple barriers, including limited access to infrastructure, financial constraints, and insufficient academic support. Similar patterns of constrained access and adaptive study practices have been documented in other African contexts, such as Ghana (Dirckinck-Holmfeld et al., 2023), where students creatively navigate ICT limitations in higher education environments. The unfamiliarity with LMS platforms often results in technological anxiety and academic underperformance, particularly among first-year students, who typically receive only minimal, one-off orientation (Sivasubramanian et al., 2022).

To mitigate these challenges, this paper proposes a conceptual framework for a DLC4LMS, specifically targeting first-year students at previously disadvantaged universities. The contribution of this paper is twofold. First, it advances the field conceptually by synthesising and reconfiguring established instructional design models into a novel, equity-sensitive framework designed for resource-constrained contexts. Second, it demonstrates how formative validation within a Design Science Research (DSR) cycle can ground theoretical frameworks in practitioner realities while maintaining transferability to other Global South contexts. By positioning equity as a design driver rather than an afterthought, the DLC4LMS framework extends existing instructional design scholarship in ways that address longstanding gaps in the international educational technology literature. This study does not evaluate student learning outcomes or user experience. Instead, it contributes an equity-sensitive instructional design artefact and reports formative, practitioner-informed validation as an early DSR cycle, intended to precede student-facing implementation and evaluation. The structure of the paper is as follows: The literature review is presented in section 2, the theoretical foundations of the framework are reviewed in section 3, the framework design is described in section 4, the adopted methodology is discussed in section 5, the results are presented in section 6 and discussed in section 7, the conclusion and recommendations are in section 8, and finally, limitations and future directions are outlined in section 9.

2 Literature review

2.1 Importance of digital literacy in higher education institutions

Digital literacy has emerged as a critical competency in contemporary higher education institutions, underpinning effective

teaching, learning, research, and administrative processes (Falloon, 2020). As higher education institutions increasingly integrate digital technologies into their pedagogical and operational frameworks, the ability of students, academics, and support staff to navigate, evaluate, and create digital content becomes essential. Firstly, according to Anthonysamy et al. (2020), digital literacy enhances students' capacity for independent and lifelong learning by enabling them to access and critically engage with a vast array of online resources. It also facilitates the development of higher-order cognitive skills such as information analysis, synthesis, and ethical reasoning in the digital environment. Instructors, likewise, require digital fluency to design and deliver technology-enhanced learning experiences that are inclusive, interactive, and aligned with 21st-century learning outcomes. Moreover, Hashim et al. (2022) indicate that digital literacy contributes to institutional readiness for digital transformation, ensuring that universities remain competitive and responsive to the evolving demands of the global knowledge economy. In the context of increasing online and blended learning modalities, digital literacy is also pivotal to promoting equity and access, particularly for students from disadvantaged backgrounds who may lack prior exposure to digital tools. Embedding digital literacy within the curriculum and institutional culture is vital for advancing academic excellence, digital inclusion, and graduate employability in the digital age (Choudhary, 2024).

2.2 Digital inequality and learning management system adoption

Digital inequality in South Africa reflects entrenched socioeconomic disparities, particularly across income, geography, race, and education. While digital infrastructure has expanded, significant gaps remain in internet access, device availability, and digital literacy, especially in rural and peri-urban areas (Mwansa et al., 2025). These disparities limit participation in the digital economy and exacerbate exclusion in education and civic life, as evident during the COVID-19 pandemic when remote learning disproportionately disadvantaged students from historically marginalised communities (Woldegiorgis, 2022). Beyond access, digital inequality includes differences in literacy, content quality, and engagement opportunities (Matli and Ngoepe, 2022). Without targeted policy and investment in digital skills and infrastructure, such inequalities may hinder inclusive development and digital transformation, as also noted in Ghana's Information Communication and Technology for Accelerated Development (ICT4AD) policy review (Adarkwah and Huang, 2023).

Although LMS offer significant potential to enhance higher education (Alotaibi, 2024), their adoption faces challenges, particularly for first-year students. Many arrive with limited digital literacy and struggle with LMS navigation, self-directed learning, and time management (Morgan et al., 2022). Inconsistent instructional design, limited technical support, and uneven lecturer engagement further hinder their experience (Calderón et al., 2022). Socio-economic barriers, such as unreliable internet and inadequate study environments, compound these issues for disadvantaged students. Addressing these challenges requires early digital skills training, standardised LMS onboarding, equitable infrastructure access, and inclusive pedagogies. As Stewart and Ivala (2017) argue, LMS spaces in South African universities can

support both empowerment and transformation when culturally responsive approaches are adopted.

3 Theoretical underpinnings and contribution

The conceptual framework in [Figure 1](#), is grounded in several instructional design and learning theories. The summary of theories, key focus and contributions are presented in [Table 1](#).

This study's central contribution lies not in large-scale empirical generalisation but in advancing an equity-sensitive instructional design framework for digital literacy in higher education. By synthesising and recontextualising multiple established theories including ASSURE for structured design, UDL for inclusivity, CoI for online presence, EquityXDesign for justice-oriented design, and Laurillard's framework for dialogic learning. The DLC4LMS offers a novel model that embeds equity and contextual responsiveness as foundational design principles. Most instructional design models were originally developed in well-resourced Global North settings; their direct application in under-resourced environments often overlooks infrastructural and cultural constraints. DLC4LMS addresses this gap by reconfiguring these models for mobile-first, low-bandwidth, and equity-challenged contexts. In doing so, it shifts the discourse on digital literacy from universalist prescriptions to contextually sensitive, Global South-anchored frameworks. The formative validation through academic staff input should not be read as evidential proof of effectiveness but as a stakeholder-informed refinement stage in the DSR cycle. This ensures that the framework is grounded in practitioner realities while remaining adaptable for further empirical testing with students in future phases.

4 Framework design and contribution

4.1 Proposed DLC4LMS framework

The DLC4LMS framework was developed through a design thinking process, drawing on the above theories in [Table 1](#). The process involved creating student personas (see [Appendix S1](#)) to reflect diverse learner profiles typical of under-resourced institutions. The framework includes structured instructional strategies, ongoing support mechanisms, and integration of mobile-friendly and AI-enhanced tools. As illustrated in [Figure 1](#), the DLC4LMS framework is built around the integration of instructional design models with inclusive, mobile-friendly learning components tailored for resource-constrained university settings.

4.2 Operationalisation of the DLC4LMS framework

To enhance practical applicability, this section outlines how the DLC4LMS framework may be enacted within a resource-constrained university context. The framework is designed as a modular, phased digital literacy course, adaptable as a standalone or integrated offering depending on institutional constraints and accreditation

requirements. [Figure 2](#) illustrates conceptualised strategies to operationalise a DLC4LMS framework.

The following subsections will explain the operationalisation of the DLC4LMS framework.

4.2.1 Course structure and implementation phases

The DLC4LMS framework can be implemented across four progressive phases as presented in [Table 2](#).

This phased approach allows for scaffolded skill development, consistent with ASSURE and Bloom's Taxonomy, while accommodating diverse learner entry points.

4.2.2 Illustrative learning activities

Peer-supported activities and discussion forums foster social and cognitive presence, as conceptualised in the Community of Inquiry framework. As presented in [Table 3](#), learning activities within the DLC4LMS framework are designed to be.

4.2.3 Assessment logic

Assessment within the DLC4LMS framework prioritises formative, competency-based evaluation. Assessment strategies may include:

- Completion of practical LMS tasks
- Low-stakes quizzes
- Participation in online discussions
- Reflective learning journals

Where institutional policies permit, the course may be credit-bearing or linked to graduate attributes to enhance student motivation and legitimacy. Alternatively, assessment incentives can be embedded within existing academic modules.

4.2.4 Equity and contextual responsiveness

Equity is operationalised through:

- Mobile-optimised design
- Minimal data consumption
- Flexible pacing
- Contextualised examples aligned with students' lived realities

These features ensure that the framework remains responsive to infrastructural limitations while supporting inclusive participation. Within DLC4LMS, equity is operationalised through explicit design constraints and rules, including:

- Mobile-first and smartphone-only compatibility
- Low-bandwidth instructional formats (compressed media, text-first alternatives)
- Flexible pacing and asynchronous participation
- Multiple representation and engagement pathways (UDL-aligned)
- Assessment-linked incentives to mitigate non-credit participation risks

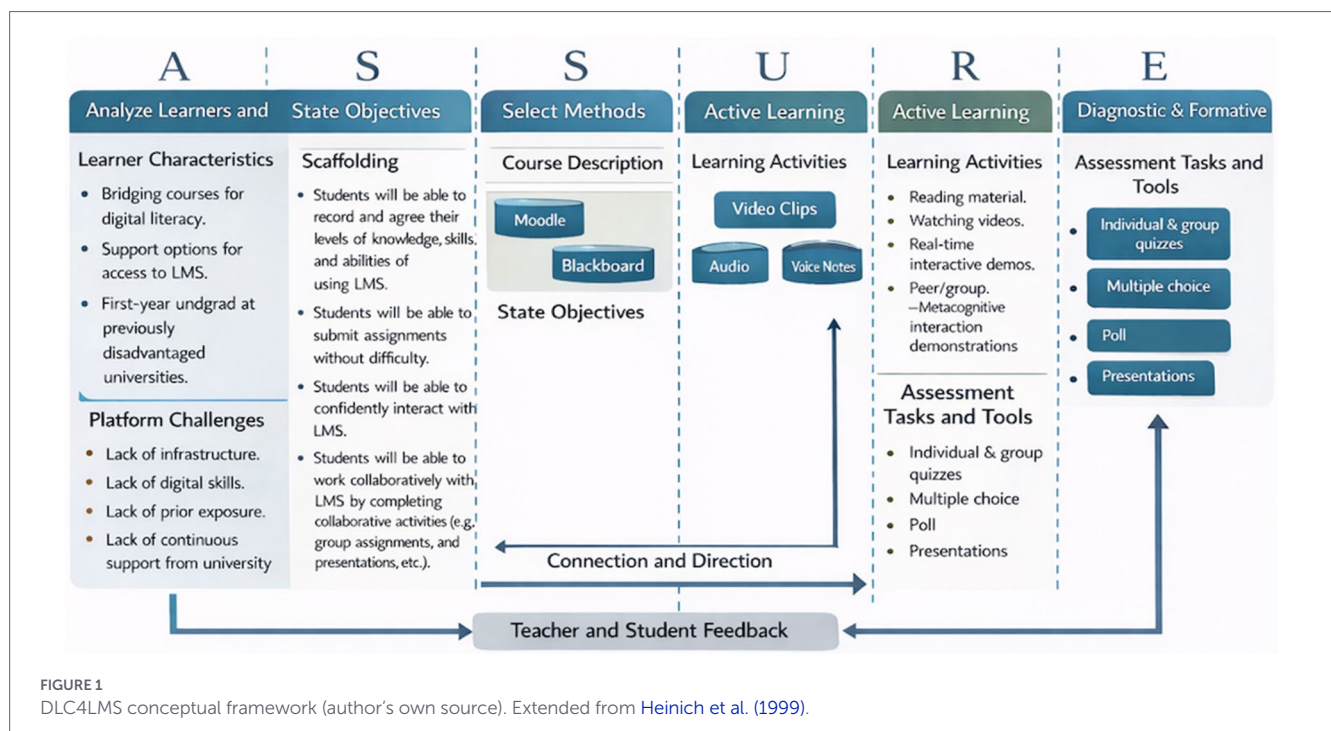


FIGURE 1
DLC4LMS conceptual framework (author's own source). Extended from Heinich et al. (1999).

TABLE 1 Adopted instructional design and learning theories.

Model/theory	Key focus	Contribution to the conceptual framework
ASSURE Model (Heinich et al., 1999)	Instructional design; technology integration	Provides a systematic process for incorporating technology in lesson planning
Universal design for learning (UDL) (Rose and Meyer, 2002)	Accessibility and inclusivity in education	Ensures that course design accommodates diverse learners and removes learning barriers
Community of Inquiry (CoI) (Garrison et al., 2000)	Online learning; cognitive, social, and teaching presence	Informs the design of engaging and interactive online learning environments
EquityXDesign	Equity-centered design thinking	Embeds principles of equity to address systemic disparities in instructional practices
Bloom's Taxonomy & Gagné's Conditions of Learning (Anderson and Krathwohl, 2001; Gagné, 1985).	Learning objectives and instructional sequencing	Support development of measurable outcomes and structured learning experiences
Laurillard's Conversational Framework (Laurillard, 2013).	Dialogic and student-centered learning	Promotes reflective, two-way learning processes between learners and educators

5 Research methodology

The study employed a three-cycle DSR process (Hevner, 2007) in Figure 3:

- **Relevance Cycle** – identified digital literacy and LMS-readiness gaps among students and lecturers through literature review and exploratory consultations.
- **Design & Development Cycle** – synthesised instructional design models (ASSURE, UDL, CoI, EquityXDesign, Laurillard) into the DLC4LMS prototype and created learner personas for testing feasibility in low-bandwidth contexts.
- **Rigour & Evaluation Cycle** – implemented formative validation with academic staff from two universities ($n = 13$) using

interviews and surveys to refine framework components and ensure contextual fit.

This iterative DSR approach allowed the framework to evolve through practitioner feedback while maintaining theoretical coherence and transferability.

5.1 Research design and instrument

The interview guide and survey prompts focused on four areas: (1) perceived digital literacy gaps, (2) LMS-related equity challenges, (3) feasibility of the proposed framework, and (4) anticipated implementation constraints. Questions were open-ended and exploratory to support formative design refinement rather

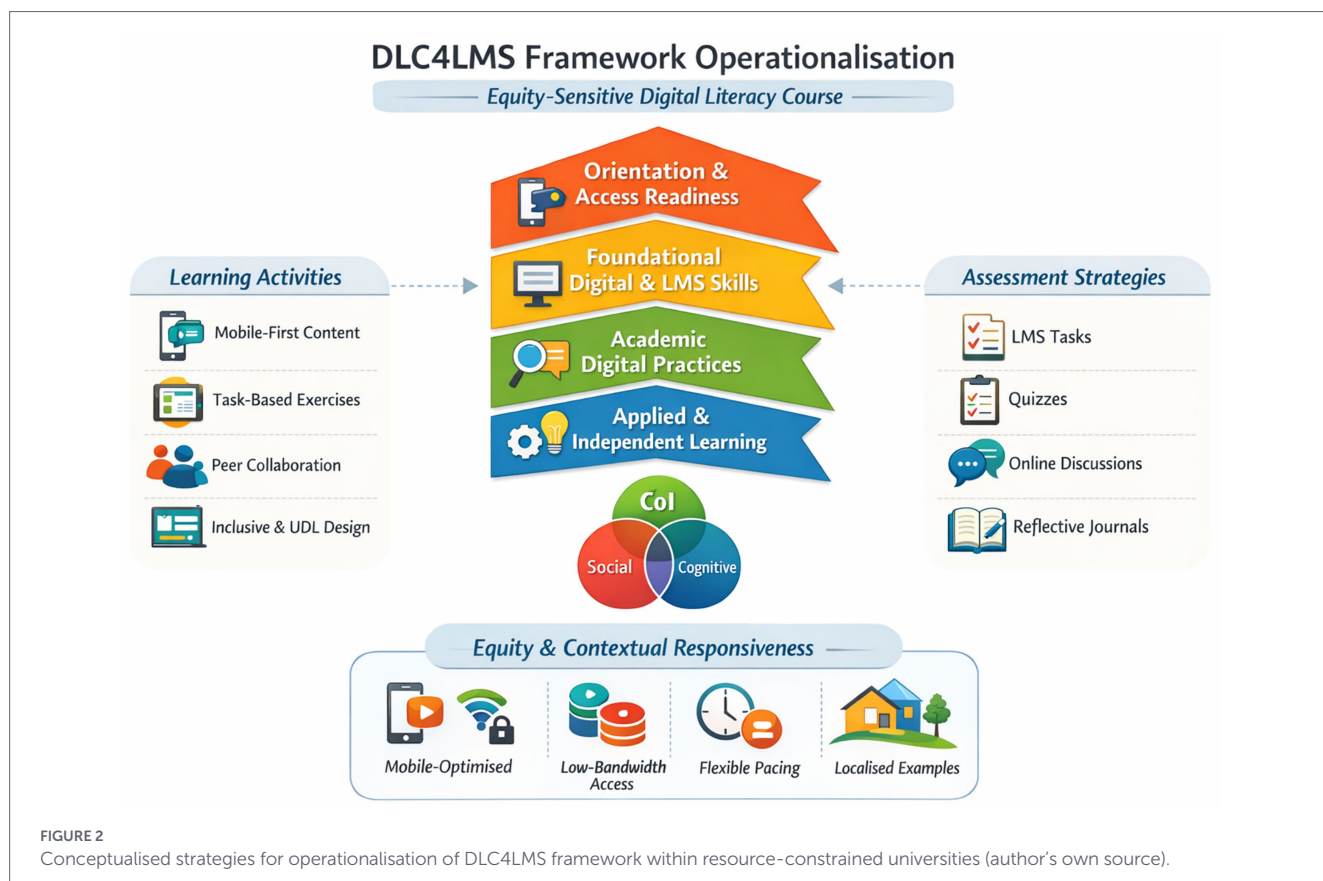


FIGURE 2 Conceptualised strategies for operationalisation of DLC4LMS framework within resource-constrained universities (author's own source).

TABLE 2 Four progressive phases.

Phases	Action
Orientation and access readiness	Focuses on device use, basic navigation skills, LMS login procedures, and mobile-first access strategies. This phase addresses digital anxiety and ensures early engagement.
Foundational digital and LMS skills	Introduces core LMS functionalities, including accessing learning materials, submitting assignments, participating in discussion forums, and managing notifications.
Academic digital practices	Emphasises information literacy, online collaboration, academic integrity, digital communication, and responsible use of emerging tools such as AI-assisted learning resources.
Applied and independent learning	Supports self-directed learning, time management, peer collaboration, and reflective digital practices aligned with disciplinary tasks.

TABLE 3 DLC4LMS learning activities.

Learning activities	Engagements
Mobile-first and low-bandwidth	This will include short instructional videos, step-by-step guides, quizzes, and discussion prompts.
Task-based	Mirroring real academic requirements such as submitting assignments, accessing feedback, and participating in online assessments.
Inclusive and flexible	Offering multiple means of engagement and representation in line with UDL.

than outcome evaluation. This study adopted a formative evaluation as the evaluation method for the developed conceptual framework. In order to implement an iterative process and modify the learning materials in response to the assessment's findings, the researchers had the chance to use formative evaluation. As a result, the online learning process proceeded according to schedule, and the evaluation's conclusions were founded on the predetermined objectives. During the evaluation phase, the designer's goal was to pinpoint and clarify the effects of the learning, which had to be

quantifiable in order to be successful. Our assessors examined a variety of factors, including the learning activities and objectives of the students, the assessments, the interaction, learner support, accessibility and usability, the overview information and content, and the course technology and tools of the chosen LMS. Students who struggled with digital skills were taken into consideration, and support for a positive learning experience was given. These factors were found to be relevant and difficult in the real-world setting.

5.2 Participants' profile and recruitment

Participants comprised academic and professional staff involved in teaching, instructional design, and digital learning support across two resource-constrained universities. Roles included lecturers, instructional designers, and learning technologists, all of whom

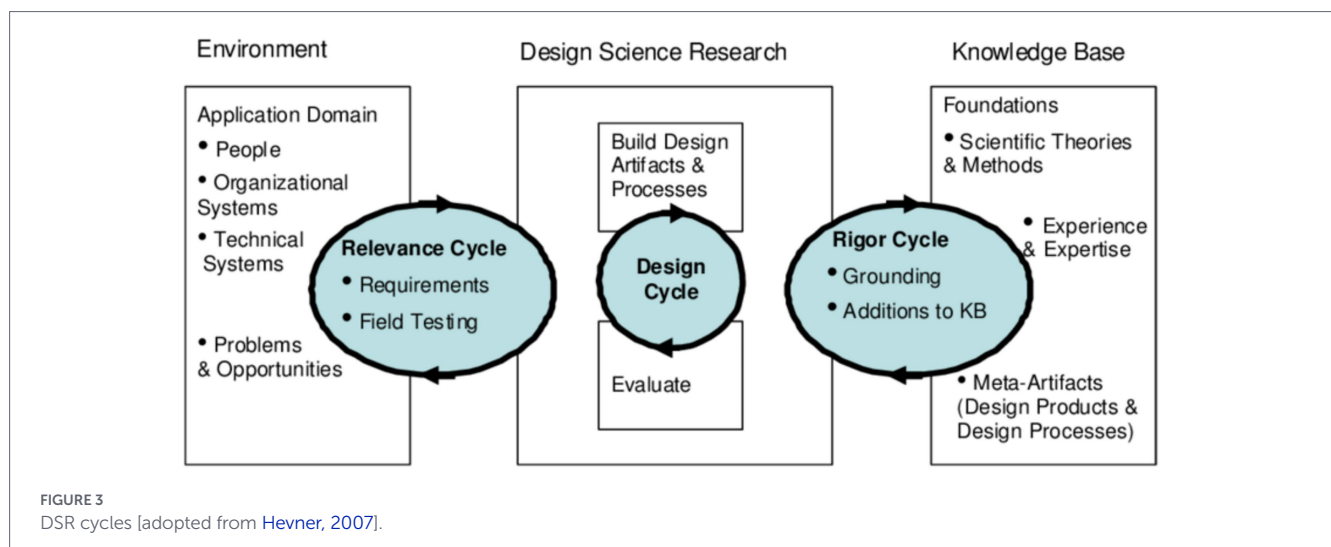


TABLE 4 Participant profile for structured interviews.

Participants	Age	Gender	Level of qualifications	Primary work environment	Job level	Job role	Job experience
Interviews 1: Case Study 1							
W1	31–50 Years	Male	Postgraduate Diploma in Education Technology	Full-Time	Lower Management	Learning Technologist	3-5 Years
W2	31–50 Years	Male	Bachelor's Degree	Full-Time	Lower Management	Instructional Designer	1–2 Years
W3	31–50Years	Female	Master's Degree	Full-Time	Middle Management	Senior Instructional Designer	6-10 Years
W4	31–50Years	Male	Master's Degree	Full-Time	Lower Management	Learning Technologist	6-10 Years
W5	31–50Years	Female	Postgraduate Diploma in Information Technology Management	Full-Time	Lower Management	Instructional Designer	1-2 Years
W6	31–50Years	Male	Honours Degree	Full-Time	Lower Management	Instructional Designer	11 Years and Above
Interviews 2: Case Study 2							
M1	31–50years	Male	Doctoral Degree	Full-Time	Middle Management	Deputy Director	11 Years and Above
M2	31–50Years	Male	Master's Degree	Full-Time	Middle Management	Senior Instructional Designer	6-10 Years

engaged with LMSs in their professional capacities. Participants had varying levels of experience in digital teaching and LMS use, providing a diverse practitioner perspective relevant to framework design.

To protect anonymity, institutional affiliations and individual identifiers are not disclosed. The participants' profiles are presented in the following Tables 4, 5.

Prior to their participation, all participants gave their informed consent. All participants were provided with an information sheet

outlining the purpose of the study, the nature of their participation, and their right to withdraw at any stage without consequence. Informed consent was obtained electronically prior to participation in interviews and/or completion of the online survey. The email included essential documentation, such as a summary of the study and an overview of the proposed conceptual framework. Upon receiving confirmation of their willingness to participate, interview dates were scheduled and conducted virtually using Microsoft Teams. Meeting links, along with a digital consent form and a Microsoft Form link for

TABLE 5 Participant profile for online survey.

Participants	Age range	Highest qualifications	Academic rank	Job experience
P1	50-59 Years	Masters Degree	Permanent Lecturer	16 Years and Above
P2	30-39 Years	Masters Degree	Permanent Lecturer	6 to 10 Years
P3	30-39 Years	Masters Degree	Permanent Lecturer	6 to 10 Years
P4	40-49 Years	Doctor of Philosophy	Senior Lecturer	6 to 10 Years
P5	50-59 Years	Doctor of Philosophy	Senior Lecturer	16 Years and Above

collecting biographical information, were subsequently shared with the participants.

The first set of interviews, involving non-academics, were conducted over a one-week period, that is from the 20th to the 26th of March, 2025. The second group of participants consisted of academic staff, specifically lecturers from both institutions. Owing to pre-existing personal contacts with some of these individuals, the researchers initiated communication via WhatsApp to request their participation and to briefly outline the purpose of the study. Once participants expressed their willingness to be involved, a Google Forms link containing both biographical and open-ended questions was distributed. This data collection process spanned a three-month period, from November 2024 to January 2025.

5.3 Ethical considerations

The study was conducted in accordance with the South African Department of Health's Ethics in Health Research: Principles, Processes and Structures (2nd edition, 2015). In line with these guidelines, research classified as minimal risk and involving adult participants acting in a professional capacity is exempt from formal ethics committee review. Consequently, institutional Research Ethics Committee (REC) approval was not required. Participation was voluntary, and no vulnerable populations were involved. To ensure confidentiality and anonymity, no personally identifiable information was collected or reported. Participants were assigned pseudonymous identifiers (e.g., W1–W6, M1–M2, P1–P5), and all data were anonymised during transcription and analysis.

Data were securely stored on password-protected devices accessible only to the research team. These ethical measures were applied consistently across all phases of data collection and are aligned with the study's DSR approach, which emphasises responsible stakeholder engagement and ethical reflexivity during artefact design and refinement. All references to "no human studies" autogenerated statements have been removed to ensure consistency with the described ethical procedures.

5.4 Study context: LMS and e-learning environment

The study was conducted within higher learning institutions using mainstream LMSs to support blended and online learning. LMS platforms were primarily used for content distribution, assessment submission, communication, and administrative functions. Teaching approaches included blended, hybrid, and fully online modalities, reflecting common practices in resource-constrained higher education environments. This contextual description establishes the technological and pedagogical environment within which the DLC4LMS framework was designed and evaluated.

5.5 Data analysis process

The qualitative data from interviews and open-ended survey responses were analysed using a thematic analysis approach, informed by Braun and Clarke's (2019) iterative coding principles and aligned with the formative evaluation purpose of DSR. Data analysis proceeded through four stages.

First, interview transcripts and survey responses were read repeatedly to achieve familiarisation with the data. Second, initial codes were generated inductively, focusing on participants' perceptions of digital literacy needs, LMS challenges, equity considerations, and implementation constraints. Third, codes were clustered into higher-order themes through iterative comparison, refinement, and consolidation. Fourth, themes were reviewed and interpreted in relation to the design objectives of the DLC4LMS framework.

Interview and survey data were analysed together and synthesised into shared analytical themes to support design refinement rather than reported separately by method. Rather than treating themes as standalone findings, the analysis focused on how recurring patterns across participants informed design decisions, framework refinement, and operational priorities. Selected excerpts are used illustratively to support analytical themes rather than to provide exhaustive representation of participant views. This approach ensured that empirical insights directly contributed to the evolution of the DLC4LMS artefact, consistent with the rigour and relevance cycles of DSR. Claims made in the Results and Discussion sections are therefore grounded in stakeholder-informed design logic rather than evaluative outcome measurement. Themes were treated as design-informing patterns rather than empirical claims about effectiveness, consistent with the formative evaluation goals of DSR.

6 Results

The findings synthesise insights from semi-structured interviews and an online survey with academic and professional staff involved in digital teaching and learning. Rather than reporting results by data source, the findings are organised into four analytical themes that capture convergent perspectives and directly informed the refinement of the DLC4LMS framework. Selected excerpts are included illustratively to support analytical claims.

6.1 Equity-driven access constraints

Across both interviews and survey responses, participants consistently identified structural access constraints as defining conditions

for first-year students in resource-constrained universities. Mobile-only device use, limited data availability, and unstable connectivity were described not as exceptional challenges but as baseline realities shaping students' engagement with LMS-mediated learning. As one participant explained,

“Most of our first-year students rely almost entirely on their phones, and data runs out very quickly if content is too heavy” (P1).

Survey responses reinforced this concern, with the majority of respondents identifying mobile access and data affordability as persistent barriers to effective LMS use. These insights positioned equity as a core design driver, informing the framework's emphasis on mobile-first design, low-bandwidth learning materials, and flexible pacing across all phases of the DLC4LMS course.

6.2 Scaffolded digital readiness and LMS familiarity

A second theme highlighted uneven levels of digital preparedness among first-year students. Participants noted that many students enter higher education with limited prior exposure to LMS environments, resulting in uncertainty, anxiety, and early disengagement when digital competencies are assumed rather than supported.

One interview participant noted that:

“We often assume students know how to submit assignments or find feedback, but many struggle with the basics at the start” (W3).

This observation was echoed in survey responses that emphasised the need for explicit onboarding and gradual skills development. In response, the DLC4LMS framework adopts a phased and scaffolded structure, beginning with orientation and access readiness before progressing to foundational LMS skills and more advanced academic digital practices. This design aligns with ASSURE and Bloom's Taxonomy, supporting incremental development rather than deficit-based assumptions.

6.3 Motivation, assessment, and institutional legitimacy

Participants consistently emphasised that student engagement with digital literacy initiatives is strongly influenced by whether such offerings are perceived as academically legitimate. Non-assessed or optional courses were viewed as particularly vulnerable to low participation, regardless of their pedagogical value. As one participant stated:

“If it's not linked to assessment or credits, students don't always see it as important” (M2).

Survey respondents similarly indicated that incentives, assessment alignment, or formal recognition were critical to sustaining student engagement. This theme informed the framework's emphasis on formative, competency-based assessment and flexible integration options, allowing institutions to implement DLC4LMS as a credit-bearing module, an embedded component within existing courses, or a supported standalone offering.

6.4 Implementation feasibility and contextual flexibility

The final theme concerned institutional feasibility and sustainability. Participants highlighted variations in staffing capacity, curriculum structures, and accreditation requirements, which influenced preferences for how a digital literacy course could be implemented. One interview participant observed that:

“A one-size-fits-all approach won't work—some faculties can embed it, others need a standalone option” (P4).

These perspectives were reflected in survey responses that favoured adaptable delivery models over rigid prescriptions. These findings informed the modular and flexible design of the DLC4LMS framework, enabling institutions to adopt the framework in ways that align with local constraints while maintaining core equity-centred design principles.

7 Discussions

The findings reported in the Results section informed the refinement and operationalisation of the DLC4LMS framework. Rather than representing outcome evaluation, these insights function as formative design inputs consistent with a DSR approach. This study does not evaluate learning outcomes but contributes a design artefact intended for subsequent student-facing implementation and evaluation. The DLC4LMS framework aligns with institutional priorities around digital transformation and inclusion. The prominence of access constraints reinforces calls to move beyond deficit narratives and instead treat infrastructural limitations as stable design conditions. By embedding equity at the level of instructional design rather than support services, the DLC4LMS framework contributes to emerging Global South scholarship that reframes digital inclusion as a pedagogical responsibility rather than a technical fix. Participant responses highlight the urgency of structured digital support for first-year students, especially those from rural and disadvantaged backgrounds. The course is seen not only as a foundational learning intervention but also as a strategic enabler of academic inclusion and graduate employability. From a theoretical standpoint, the framework contributes to the discourse on instructional design by reconceptualising digital literacy as both a cognitive and structural capability. The integration of UDL, CoI, and EquityXDesign within a DSR paradigm enables a holistic response to digital access, engagement, and equity. Especially, the adaptation of these theories to low-bandwidth, mobile-first contexts marks a significant shift from Global North-centric instructional models. Participants consistently noted on the crucial role of digital literacy courses in enhancing student learning experiences, particularly for students from disadvantaged backgrounds. Digital literacy was recognised not only as an academic necessity but also as a foundation for future career success. However, for the course to be effective, it should be practical, accessible, ongoing, and integrated into the broader academic framework. The recurring theme throughout the interviews emphasised the importance of bridging the digital divide, which is in congruent with [Mwansa et al. \(2025\)](#), as many students had limited exposure to technology prior to university ([Matli and Ngoepe, 2022](#)). Participants

highlighted the need for foundational digital skills to ensure students could successfully engage with LMS platforms, online assessments, and blended learning environments (Calderón et al., 2022). Additionally, participants acknowledged the role of digital literacy in reducing anxiety related to technology use, enhancing independent learning, and developing future employability skills.

Two authors, Falloon (2020) and Spante et al. (2018), consistently noted that such a course is perceived as a strategic intervention to bridge digital inequities by equipping students, many of whom have limited prior exposure to digital technologies, with foundational ICT competencies. Participants consistently articulated that foundational digital literacy is not merely a technical prerequisite but a structural enabler of academic agency and inclusion, especially within blended and LMS-mediated environments. Furthermore, the course is seen as instrumental in facilitating students' transition from traditional classroom settings to blended and fully online learning environments. Anthonysamy et al. (2020) was in support of the idea that improved student digital proficiency would also enhance teaching efficiency, as lecturers could allocate more instructional time to academic content rather than providing basic technical support.

Participants expressed differing views on the optimal integration of the digital literacy course within existing academic structures. While some advocated for a standalone module to emphasise the importance of digital literacy, others supported integration into existing courses such as Computer Literacy or End-User Computing. There was a consensus that the course must be designed in a way that engages students, with some participants highlighting the need for academic incentives such as grading to increase student participation. The idea of a blended approach was also proposed, combining integration with standalone modules, depending on the institutional context and student behavior.

The findings were congruent with Bradley (2021) and Falloon (2020), who believe that feedback regarding the design of the course content is emphasising the need for a tiered approach, starting with basic skills and advancing to more complex digital competencies. The course should be interactive and student-centred, incorporating self-help videos, quizzes, and practical tasks that students will encounter throughout their university journey. A significant focus was placed on digital citizenship, which would go beyond operational skills to include ethical considerations, privacy, and the responsible use of digital tools like AI. Some participants also suggested that the course should be aligned with academic survival, equipping students with the skills to navigate LMS platforms, online libraries, and other academic resources.

All participants agreed that the digital literacy course aligns with their university's strategic goals, particularly the infusion of technology into teaching and learning and the preparation of students for the digital workforce. The course was commonly perceived as central to advancing universities' strategic goals of cultivating digitally competent graduates and fostering inclusive, technology-enabled learning environments. The findings of the study are in agreement with Choudhary (2024), as participants believed that digital literacy was linked to the institutions' long-term goals, such as improving employability and supporting blended and remote learning.

The DLC4LMS framework advances instructional design scholarship by positioning equity as a primary design logic rather than a peripheral concern. In contrast, existing technology integration models

such as Technological Pedagogical Content Knowledge (TPACK) and the Substitution–Augmentation–Modification–Redefinition (SAMR) model foreground the teacher's role in aligning pedagogy and technology or in enhancing tasks through technology substitution and transformation. While these models have been influential in guiding technology integration, they were developed in well-resourced Global North contexts and therefore assume stable connectivity, institutional support, and universal device access. The DLC4LMS framework extends this discourse by embedding contextual equity mediators, access, infrastructure, and institutional readiness, into the design core. This shift reframes digital literacy not simply as a matter of pedagogical competence but as a systemic and structural condition for participation in digital learning. By combining DSR with EquityXDesign principles, the study bridges theoretical innovation and practical relevance: it not only conceptualises inclusivity but operationalises it for low-resource, mobile-first learning environments. The framework therefore contributes to global conversations on sustainable and equitable digital transformation, providing a replicable, evidence-informed model for digitally marginalised higher-education systems. While the framework is informed by practitioner insights, future work is required to empirically examine student experiences and learning outcomes.

8 Conclusions and recommendations

The study proposes a structured, context-sensitive digital literacy course framework to support first-year students in South Africa's disadvantaged universities. The DLC4LMS framework offers a theoretically grounded and context-responsive design that warrants further empirical testing with students in resource-constrained higher education settings. Its synthesis of multiple theoretical traditions offers a flexible but principled response to the challenges of digital literacy in higher education, particularly where digital inequities intersect with socio-economic disadvantage.

Although validated within two South African institutions, the framework's principles are transferable to other Global South contexts where students face similar infrastructural and pedagogical barriers. For example, Southeast Asian and Latin American universities grappling with bandwidth limitations, or refugee education initiatives constrained by mobile-only access, could adapt DLC4LMS as a scalable model for fostering digital inclusion. By positioning equity not as an afterthought but as a design driver, the framework provides a blueprint for reimagining digital literacy curricula in under-resourced environments worldwide.

Based on the findings and the design logic of the DLC4LMS framework, the following recommendations are proposed for resource-constrained higher education contexts:

- Digital literacy courses should adopt a mobile-first and low-bandwidth design as a baseline assumption rather than a contingency, reflecting students' dominant access conditions.
- Institutions should prioritise data-light instructional strategies, including compressed media, downloadable resources, and asynchronous engagement options.
- Digital literacy initiatives should be integrated into existing curricula or linked to formal incentives (e.g., credit-bearing modules or graduate attributes) to improve student participation and legitimacy.

- Scaffolded, phased course structures are recommended to support students with limited prior digital exposure and to reduce digital anxiety during the academic transition.
- Where academic support capacity is limited, automation and self-help mechanisms (e.g., LMS prompts, walkthrough videos, FAQs) should be embedded into course design.
- Equity should be treated as a design principle shaping content, delivery, assessment, and integration, rather than as a *post hoc* support intervention.

9 Limitations and future directions

This study is subject to several limitations that should be acknowledged. First, the empirical component is deliberately limited in scope, with data drawn from a small sample ($n = 8$ interviews; $n = 5$ surveys) across two South African universities. This was not intended to produce statistically generalisable results but rather to serve as formative validation within a DSR cycle. In line with DSR methodology, stakeholder feedback was used to iteratively refine the conceptual framework rather than to test its effectiveness at scale. Second, because the framework has not yet been piloted with students, claims about its impact on learning outcomes remain provisional. Future studies should therefore implement DLC4LMS in real-world instructional contexts to evaluate student engagement, academic performance, and long-term digital readiness. Third, while the framework synthesises multiple theoretical models, further research is required to explore how these models interact in practice within diverse institutional contexts. By framing these limitations explicitly, this study clarifies its contribution: the presentation of a theory-informed, equity-sensitive framework that can be adapted, tested, and scaled in under-resourced higher education settings worldwide. Consistent with DSR, this study prioritises artefact relevance and theoretical grounding over empirical generalisation in its current phase.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Author contributions

KY: Data curation, Formal analysis, Funding acquisition, Investigation, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft,

Writing – review & editing. GK: Writing – original draft, Writing – review & editing. TM: Conceptualization, Writing – original draft, Writing – review & editing.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2026.1744029/full#supplementary-material>

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