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Technology-enhanced universal design for learning: Examining digital tools that support accessibility and differentiation in diverse classrooms

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Abstract

Technology-enhanced Universal Design for Learning (UDL) has been developed to tackle learner variability in digitally mediated classrooms and has been promoted as a framework for inclusive education. This review synthesizes evidence across early childhood, primary, secondary, higher education, special education, adult learning and inclusive education. The findings indicate that digital technologies do not act merely as tools but as structural enablers of UDL. Technology-supported UDL embedded accessibility infrastructure, multimodal representation systems, differentiated instruction, personalized learning pathways, and non-stigmatized universal supports within instructional and institutional systems. Professional capacity-building was identified as a key factor in effective implementation, with structured UDL training producing measurable pedagogical changes and enhanced instructional design. Digital platforms facilitated multimodal access, assistive and AI-augmented supports, adaptive learning systems, learning analytics, and personalized scaffolding. Executive functioning, self-regulated learning, learner agency and sustained engagement were promoted through interactive, gamified, and collaborative digital practices. At curricular, instructional, and policy levels, UDL provided a proactive, anticipatory design approach that merged accessibility and differentiation. Challenges included infrastructure gaps, digital inequities, fragmented implementation, inadequate training, and limited systemic integration, particularly in low-resource and marginalized contexts. When supported by ongoing professional development, coherent digital infrastructures, and equity-centered policy frameworks, technology-enhanced UDL can become a systemic model for inclusive education. Future efforts should prioritize system-level capacity-building, aligned integration of AI, assistive technologies and UDL, and scalable digital inclusion strategies that align with policy frameworks to enable sustainable, equitable inclusive learning ecosystems.

Keywords: Universal Design for Learning; Technology-enhanced learning; Digital accessibility; Inclusive education

1. Introduction

Digital transformation increasingly drives educational systems around the world, with learning environments organized around online platforms, multimedia content, adaptive technologies and data-driven instructional systems (1, 2). While these developments have advanced access to educational resources, they also illuminate pervasive inequalities in participation, accessibility and learning outcomes for students with diverse cognitive, linguistic, sensory, cultural and functional needs (1, 3). Traditional models of inclusion, based on retroactive accommodation and deficit oriented classifications, are inadequate to address the complexity and variability of learners in digitally mediated classrooms (4, 5). Consequently, there is increasing acknowledgment that inclusion has to be structurally mainstreamed within curriculum planning, teaching practice and systems in institutions, rather than just treating it as an adjunct or compensatory process (6).

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Universal Design for Learning (UDL) has emerged as a broad pedagogical framework that addresses this challenge by reframing inclusion as proactive design, not reactive support (7). Guided by the principles of multiple means of representation, multiple means of action and expression, and multiple means of engagement, UDL encourages stakeholders to focus not on individual learner deficits but rather on configuring learning environments themselves (7, 8). UDL focuses not on reorienting instruction once barriers have emerged, but on forecasting potential barriers and creating flexible learning designs that anticipate individual needs, incorporating gradual removal of structural challenges to participation systemically (8). In this model, accessibility, differentiation and engagement are not additions to instruction but instead core design properties that determine how curricula, learning environments and assessment systems are designed (7, 9).

Digital technologies play an important role in UDL enactment by not only acting as instructional tools, but as infrastructures that enable inclusive design. Multimedia platforms, adaptive learning systems, assistive technologies, artificial intelligence, learning analytics and digital collaboration environments became increasingly mediated representations of content in educational contexts as well the modalities through which learners interacted with knowledge and demonstrated their learning (10, 11). Such technologies provide unprecedented opportunities to integrate accessibility features, accommodate learner variability, personalize learning pathways, and enable flexible forms of participation (12, 13). Meanwhile, the rapid growth of learning technology has led to patchwork practices of implementation and structural integration between institutions as well as enduring digital divides (1, 14), prompting difficult questions about how technology might support inclusion rather than reproduce established structural exclusions.

While a burgeoning literature has explored the intersection of UDL and ed tech, much of this scholarship continues to exist in silos across disciplines, educational domains, and methodological traditions (15, 16). Most studies of tools, interventions or implementations are quite isolated and decontextualized from pedagogical, institutional and policy ecosystems in which digital technologies are situated (17). Consequently, there is little synthesis of how technology-enhanced UDL operates as a systemic framework for inclusive learning across various learning environments, learner populations and educational systems (17, 18). Existing reviews often center on tool-based affordances or instructional strategies while overlooking structural integration, professional capacity-building, institutional alignment and equity implications (15).

The aim of this paper is to address this gap in the literature by synthesising empirical evidence from seventeen studies investigating technology-enhanced UDL across early childhood, primary, secondary, higher education, special education and adult learning and inclusive educational contexts. Rather than approaching digital tools as augmentative supports, this review oriented around a structural perspective to show how digital technologies can be seen as enabling infrastructures that integrate accessibility, differentiation, learner agency, engagement and inclusion into instructional, institutional and policy systems. By identifying the structural conditions that allow technology to significantly foster UDL as a practical framework, this synthesis contributes to an integrated evidence base that can help educators and policymakers plan for inclusive digital pedagagy and institutional design. It also offers actionable insights for educators, institutional leaders and policymakers by identifying evidence-guided avenues toward sustainable, equitable and systemically adopted technology-infused models of inclusion in varying educational settings.

2. Methods

This narrative review synthesized empirical evidence from seventeen peer-reviewed studies investigating technology-enhanced UDL across early childhood, primary, secondary, higher, special, adult, and inclusive education contexts. Studies were included based on their focus on leveraging digital technologies that support accessibility, differentiation, learner engagement, and inclusive instructional design in alignment with UDL principles. Findings were thematically analyzed to identify complementary and convergent phenomena across studies. Themes were iteratively organized to reflect domains of technology-enhanced UDL implementation, including professional capacity-building, accessibility infrastructure, differentiated instruction, digital scaffolding, learner engagement, inclusive design, systemic integration, structural barriers, and equity outcomes.

3. Results and Discussion

3.1. Professional Development and Teacher Preparation for Technology Enhanced UDL

Teacher professional development became one of the cornerstones to efficaciously servicing UDL through meaningful digital integration across projects. Intensive training interventions yielded significant didactic change. A statistically

significant effect was found on classroom implementation of UDL principles following a five-day UDL training institute such that teachers who received training yielded higher total UDL observation scores than their untrained counterparts, whose observations either improved only slightly or not at all (19). Interaction between participation in professional development and UDL implementation was significant (Wilks' Lambda F (1,141) = 4.87, p <. 05), creating a proximal link between training and instructional change (19). School administrators noted similar improvements in instructional planning capacity, such as goal-setting, lesson design, and learning outcome alignment with UDL principles (19), with results consistent across grade levels and general and special education settings.

Additional evidence indicated that technology access alone was not enough to create an inclusive practice without the knowledge and capacity for pedagogical integration and instruction (20). UDL-Training related to better lesson design for representation, action, and expression of all students as well as higher confidence in digital and online teaching environments (21). Even in the absence of formal UDL training, teachers demonstrated implicit adherence to UDL principles by routine digital practices indicating latent readiness for technology-enhanced UDL implementation (22).

At the systems level, professional development ecosystems could incorporate UDL training, digital pedagogy and assistive technology instruction as part of a unified capacity-building framework (23). Structured supports included coaching, mentoring, professional learning communities and blended learning models integrating face-to-face and digital formats (23). Webinars, online courses, virtual coaching, hybrid training structures, asynchronous and synchronous seminars, collaborative planning, peer feedback and the sharing of digital projects comprised digital professional learning ecosystems (23, 24). Needs-based digital inclusion planning targeted professional development to capacity gaps and created opportunities for reflective practice, pedagogical documentation of classrooms and analysis of instructions using digital platforms leading toward continuous pedagogical transformation (23, 24).

Teachers with conceptual knowledge of inclusive principles reported that they lacked sufficient UDL understanding, literacy in practice, and implementation skills. This makes the need for structured, system-level professional development persistent (25, 26, 27, 28, 29, 30). Some of the barriers cited were teacher attitudes, belief systems, skill deficits, inconsistent training structures, and limited institutional support mechanisms (25, 26, 27, 28).

3.2. Technology-Integrated UDL as a Structural Framework for Inclusive Learning Design

Throughout the aggregate range of evidence presented, UDL was universally identified as a conceptual basis for integrating technology in ways that scaffolded systemic consideration of learner variability. UDL was operationalized using its three foundational principles, which are multiple means of representation, multiple means of action and expression, and multiple means of engagement, with digital technologies integrated to serve as the main mechanisms of implementation (17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34).

Technology-enhanced UDL instruction was forethoughtful and proactive, embedding accessibility and differentiation prior to contacting learners rather than as accommodations (28). The design of learning environments was sensitive to all learners and included those with dyslexia, attention deficit hyperactivity disorder (ADHD), sensory differences, language needs, motor difficulties (fine/gross), multilingualism issues, adult learning needs in addition to the general education profile within holistic unified digital learning systems(25, 26, 27, 28, 29).

Rather than a resource, technology was described as the core structural infrastructure of UDL implementation, providing an organizational framework for the design of inclusive curriculums and institutional accessibility systems (17, 23, 25, 27). Digital adoption was consistently articulated as needs-driven for this purpose whereby alignment existed between profiles of the learners, pedagogical goals and digital affordances, rather than generic technology integration (32).

Within innovative systems, digital technologies enabled equitable curriculum architectures, institutional accessibility models, adaptive learning paradigms, and quality-of-life support services, diversifying learning opportunities consistent with the strengths and challenges of learners rather than deficit-centered categorizations (25, 27). UDL served as a unifying pedagogical framework guiding the use of technology in ways that enhanced accessibility and inclusion at organizational, instructional, and evaluative levels (23, 24, 32).

3.3. Digital Accessibility Infrastructure and Multimodal Representation Systems

The studies revealed the widespread usage of digital technologies to furnish a variety of representation modalities and create embedded accessibility structures. Digital environments aligned with UDL consistently integrated visual, auditory, textual, and multimodal formats to support the needs of learners with sensory, cognitive, linguistic, and processing differences (17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34).

The representation systems consisted of multimedia content types like audio, video, text, visuals, podcasts, interactive videos, digital literacy platforms, immersive VR/AR tools and blended learning environments or multimedia instructional modules or classrooms (17, 20, 21, 22, 23, 25, 26, 28, 30, 31, 33). Accessibility-supportive tools included text to speech and speech to text, adjustable text size, translation systems, captioning and subtitling, adaptive visuals, audio delivery options, multi-layered interfaces with only one layer turned on at a time and embedded support features (17, 20, 25, 29, 33).

Embedded digital accessibility scaffolds such as animated pedagogical agents (M = 2.2, SD = 0.92), passages read aloud (M = 3.0, SD = 1.25), sentence starters (M = 2.88, SD = 0.99), and story-highlighting tools (M = 3.18, SD = 0.98) were helpful to their comprehension and engagement in published empirical work within the literature (31).

Assistive technologies were implemented in systematic fashions: voice dictation systems, scaffolded verbal communication tools, AAC systems, adaptive hardware, mobility aids, sensory supports and recording technologies (23, 25, 28, 29, 32). AI-augmented AAC systems integrated adaptive text prediction, symbol mapping, and natural language processing to facilitate communication and classroom participation for individuals with limited expressive speech (25).

Digital representation systems served as forms of embedded accessibility infrastructures, offering sustained access throughout instructional contexts rather than transitory accommodations (17, 23, 25, 27, 28, 32, 34).

3.4. Technology-Enabled Differentiation, Learner Variability, and Personalized Learning Pathways

Differentiated instruction, learner variability and personalized learning pathways were supported by the use of digital technologies. ICT and multimedia tools facilitated adaptation of activities to pupils' abilities, customization of learning tasks, and diversification of expression format (22, 26). Lesson design based on UDL allowed students to demonstrate learning in posters, oral presentation, multimedia presentations, written narratives, digital portfolios, audio recordings and podcasts recordings; video and interactive artefacts (17, 20, 25, 26, 28, 29, 30, 31, 33). Digital drafting tools, graphic organizers, multimodal scaffolds, captions and images were used by students to support writing fluency, comprehension development, executive function and cognitive scaffolding (20). Multimedia technologies were associated with improved scientific writing performance, literacy development and academic engagement (21).

Adaptive learning systems, artificial intelligence–driven learning analytics, high- and low-tech digital backpack models, personalized feedback loops, modular scaffold systems, and intelligent tutoring system frameworks were identified as mechanisms of digital differentiation (17, 25, 27, 32). Clustering of learners by learning preference, prediction of support needs and tailoring of the delivery of content were facilitated through learning analytics (32).

The effectiveness of technology-enabled differentiation was shown through quantitative evidence. In Strategic Reader, students with learning disabilities in the online condition showed a statistically significant +10.4% increase ($p < 0.05$) in standardized reading score compared to a +6.58% non-significant difference for offline conditions. Under online conditions, teachers used student data three times as much and implemented significantly more customized interventions (67 versus 12), showcasing data-driven personalized instruction (31). Differentiation was applied in a non-categorical way, organizing instruction around skill needs rather than learner designations, facilitated through dynamic digital learning contexts (28).

3.5. Digital Scaffolding, Cognitive Accessibility, and Self-Regulated Learning

Digital tools simultaneously bolstered executive functioning, self-regulation, and cognitive accessibility. ICT and multimedia mediators assisted in the process of planning, strategy development, information management, goal-setting, methods of self-directed study and structured learning guidance (22). Information management and self-monitoring processes were aided by digital maps, outlines, guides and organizers (22).

The technology-supported scaffolding was characterized as incremental, flexible, fadeable and responsive to learner variability allowing adaptive learning progression (20). Multimedia technologies promoted language development, executive functions and comprehension processes specifically in students with special educational needs (21). AI-supported systems provided personalized guidance, adaptive scaffolding and responsive learning supports for learners based on UDL principles (32).

In addition, self-regulation was facilitated by task-management platforms, digital planners, progress-tracking dashboards, learning analytics systems, reflective digital tools and self-monitoring systems (25, 29, 31, 33). Performance data, progress graphs and reflective learning analytics supported metacognitive awareness and learning independently based on performance data (31).

3.6. Engagement, Motivation, Participation, and Learner Agency Supported by Technology

The results consistently showed that the use of digital media increased learner engagement, motivation, affective participation, and learner agency. There was an increase in student interest and willingness to learn when using multiple presentation formats (21). Compared with textbooks, students expressed greater relaxation, enthusiasm, and engagement when learning via computers, video games, and digital media (21).

Teachers applied ICT and multimedia tools to enhance the relevance, authenticity, and contextualization of learning content by linking instruction with students' real-life experience and previous knowledge (22). Digital tools facilitated interest recruitment, attention maintenance, and affective engagement across diverse learners (21, 22).

The engagement strategies analyzed were gamification, educational games, role-playing, problem-solving tasks, interactive simulations, collaborative platforms, mobile learning applications and multisensory activities within gaming environments (26, 28, 29, 30, 33). These strategies fostered social interaction, peer support, collaboration, and deeper learning. Quantitative data showed high utilization of digital learning tools such as gamified platforms (M = 4.30, SD = 0.799), flexible online environments (M = 4.33, SD = 0.767), multimedia resources (M = 4.26, SD = 0.836), mobile learning applications (M = 4.25, SD = 0.843), and immersive VR/AR tools (M = 4.19, SD = 0.897) (30).

Digital collaboration tools facilitated joint production of learning outcomes, cross-disciplinary projects, community-based learning and inclusive participation (24). Digital authorship and student-directed projects fostered motivation and authentic engagement (24). AI-enabled learning environments embraced multimodal interaction and learner-centered experiences, establishing AI as a foundational inclusive asset rather than merely a technical add-on (24, 32). Global learning platforms facilitated virtual exchanges, international collaborations, and global academic networks making access independent from geographical limitations (34).

3.7. Universal Access, Non-Stigmatized Digital Supports, and Proactive Inclusive Design

Digital accessibility tools were framed as universal resources instead of individualized accommodations (20). UDL lessons focused on proactive design that considered selection options, ensured universal availability of assistive technologies, and avoided stigmatization with the use of digital supports (20). Digital tools were intended for use by all students, instead of only those with recognized disabilities or individual education plans (20).

Technology-enabled UDL frameworks supported inclusive learner participation, flexible access to learning materials, and sustainable digital learning systems that supported all learners across ability levels (21). Teachers developed diversified digital practices in line with the logic of universal design rather than those of disability-specific intervention (22).

Inclusive digital systems were defined by built-in accessibility, anticipatory design standards, and universal design integrated into platforms and interfaces (32). Models grounded in UDL emphasized anticipating learner diversity and integrating accessibility during conception of instructional material rather than retrofitting accommodations (23, 24, 32).

3.8. Structured Digital Infrastructures for Inclusive Curriculum and Resource Management

Technology enabled systematic organization of instruction via electronic repositories, structured digital file systems, organized learning platforms and adaptive resource management systems based on learning objectives, skill levels and learner needs (28). Digital organization facilitated access to materials, adaptive grouping strategies, long-term resource accessibility and institutional knowledge continuity (28). At the system level, digital integration supported inclusive curriculum redesign, institutional accessibility frameworks, digital equity initiatives and adaptive learning infrastructures (25, 27, 28).

3.9. UDL Principles as a Framework for Digital Design and Policy Alignment

UDL principles were embedded systemically through digital instructional design. Observation rubrics and evaluation frameworks incorporated the three UDL principles and corresponding guidelines in classroom practice (19). Digital and multimedia tools were integrated at the organizational, instructional, and evaluative levels of teaching practice (22).

Universal design was recognized in policy frameworks as incorporating assistive technology, advanced technologies and accessibility infrastructures (23). National and international policies positioned UDL as a foundational framework for equitable and inclusive education supported by technology (23, 34). Systemic models integrated technology, UDL, inclusive education, professional development, curriculum design and evaluation in unified inclusion frameworks (23,

24). Equity-centered policies, institutional enforcement of accessibility standards, infrastructure investment, professional development systems, collaborative models and evaluation frameworks were essential for sustainable digital integration (30, 32).

3.10. Structural Barriers and Systemic Constraints to Technology-Enhanced Inclusion

Studies identified persistent structural and systemic barriers including limited infrastructure, lack of institutional support, inadequate training, resource limitations, time constraints, fragmented implementation processes, rigid curricula, scalability challenges, data security concerns, and technical integration limits (17, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34).

Digital inequity resulted from lack of devices, poor connectivity, low digital literacy and unreliable infrastructure especially in low-resource, rural, refugee and marginalized contexts (27, 34). AI and assistive technologies were often implemented in fragmented ways without integrated alignment with UDL frameworks (32). Global digital partnerships and innovation models sometimes reproduced inequalities and marginalization in low-resource settings (34). Institutional support was uneven, and lack of systematic integration across systems limited digital inclusion (17, 25, 27, 32, 34).

3.11. Building Towards Equity, Access, Social Justice, and Learning Outcomes

Technology-enhanced UDL supported equitable access, inclusive participation, and barrier-free learning environments for learners with disabilities and diverse learning profiles (27, 29, 30). Digital tools lowered access barriers, enhanced independence, and enabled more inclusive participation across diverse learner populations (29, 30). Persistent digital inequities, however, disproportionately affected marginalized learners, especially refugees and those in low-resource contexts with limited infrastructure and adaptive platform access (27, 34). Technology-enhanced UDL explicitly aligned with social justice goals by providing equitable learning opportunities, flexible access, and individualized learning pathways (27).

Use of technology-enhanced UDL-based instruction was associated with positive academic, cognitive, and psychosocial outcomes, including improvements in English language achievement, reading skills, vocabulary learning, mathematics performance, engagement, motivation, self-regulation, student–teacher relationships, access to learning materials, flexible assessment options, cooperation, and inclusive learning participation (21, 26, 29, 30, 31, 33). Quantitative evidence demonstrated statistically significant gains, including improved standardized reading performance among students with learning disabilities (31).

Implications and Recommendations

Technology-enhanced UDL is a structural framework for inclusive education rather than merely a pedagogical add-on (7, 35). Digital technologies serve as enabling infrastructures to embed accessibility, differentiation, engagement, and learner agency into instructional design, curriculum architecture, and institutional systems (1, 36). Inclusion is thus reframed as a systemic design issue rather than an individual accommodation process, with UDL providing a coherent framework for proactive, anticipatory inclusion (5, 7). Professional capacity-building emerged as a key driver of effective implementation (16). Teacher education, in-service professional development, and leadership programs should integrate UDL with digital pedagogy and assistive technology within cohesive professional learning ecosystems (37, 38). Provisioning technology alone is insufficient; sustainable impact requires continuous training, coaching, and institutional support structures (14).

At policy and systems levels, equity-centered investment in digital infrastructure, enforcement of accessibility standards, and coherent alignment of UDL, inclusive education, and digital transformation agendas are essential (1). Institutional strategies must prioritize universal access to non-stigmatized digital supports and integrated accessibility design across platforms and curricula (17). Future research should progress beyond descriptive adoption studies to implementation science, scalability models, and longitudinal impact evaluations, especially in low-resource and marginalized contexts (9, 17). This will support evidence-based pathways for translating technology-enhanced UDL from innovation to sustainable, system-level inclusive practice (18, 35).

4. Conclusion

Technology-enhanced UDL provides a system-level framework for inclusive education in which digital technologies act as structural enablers of accessibility, differentiation, engagement, and learner agency rather than supplemental tools. Successful implementation depends on integrated teacher capacity-building, embedded digital accessibility

infrastructures, and supportive institutional and policy frameworks. Proactive incorporation of inclusive design and personalized learning pathways ensures equitable participation, sustained engagement, and improved learning outcomes, positioning technology-enhanced UDL as a scalable, transformative strategy for inclusive education across diverse settings.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Gottschalk F, Weise C. Digital equity and inclusion in education: An overview of practice and policy in OECD countries. OECD Education Working Papers. 2023(299):0_1-75.

[2] Vortia W, Djokoto NK. DATA-DRIVEN DECISION MAKING IN K-12 EDUCATION: A REVIEW OF ASSESSMENT TOOLS AND INSTRUCTIONAL INTERVENTIONS. EPRA International Journal of Environmental Economics Commerce and Educational Management. 2025.

[3] Dastyari A, Jose C. Achieving inclusive and equitable quality education for all: The importance of digital inclusion. Alternative Law Journal. 2024;49(4):282-7.

[4] Behling KT, Tobin TJ. Reach everyone, teach everyone: Universal design for learning in higher education: West Virginia University Press; 2018.

[5] Nieminen JH. Assessment for Inclusion: rethinking inclusive assessment in higher education. Teaching in higher education. 2024;29(4):841-59.

[6] Unesco. Global education monitoring report 2020: Inclusion and education-all means all: UN; 2020.

[7] Boysen GA. A critical analysis of the research evidence behind CAST's universal design for learning guidelines. Policy Futures in Education. 2024;22(7):1219-38.

[8] Rao K. Inclusive instructional design: Applying UDL to online learning. The Journal of Applied Instructional Design. 2021;10(1):83-97.

[9] Almeqdad QI, Alodat AM, Alquraan MF, Mohaidat MA, Al-Makhzoomy AK. The effectiveness of universal design for learning: A systematic review of the literature and meta-analysis. Cogent Education. 2023;10(1):2218191.

[10] Du Plooy E, Casteleijn D, Franzsen D. Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. Heliyon. 2024;10(21).

[11] Tan LY, Hu S, Yeo DJ, Cheong KH. Artificial intelligence-enabled adaptive learning platforms: A review. Computers and Education: Artificial Intelligence. 2025;9:100429.

[12] Dumitru C, Muttashar Abdulsahib G, Ibrahim Khalaf O, Bennour A. Integrating artificial intelligence in supporting students with disabilities in higher education: An integrative review. Technology and Disability. 2026;38(1):3-24.

[13] Shardey E, Nabi F, Vortia W. Teacher Readiness for AI and Digital Tools in K-12 Classrooms: A Review of Professional Development Trends and Gaps. International Journal For Multidisciplinary Research. 2025.

[14] Murillo-Jiménez H, Centeno-Alarcón M, Buele J, Yumbla F, editors. Analyzing barriers to the effective implementation of technological tools in inclusive education: a scoping review. Frontiers in Education; 2025: Frontiers Media SA.

[15] Saenen L, Stevens R, Hermans K, Struyven K, Emmers E. From principles to practice: Universal design in higher education—A systematic review. Review of Education. 2026;14(1):e70129.

[16] Zhang L, Carter Jr RA, Greene JA, Bernacki ML. Unraveling challenges with the implementation of universal design for learning: A systematic literature review. Educational Psychology Review. 2024;36(1):35.

[17] Bray A, Devitt A, Banks J, Sanchez Fuentes S, Sandoval M, Riviou K, et al. What next for Universal Design for Learning? A systematic literature review of technology in UDL implementations at second level. British Journal of Educational Technology. 2024;55(1):113-38.

[18] King-Sears ME, Stefanidis A, Evmenova AS, Rao K, Mergen RL, Owen LS, et al. Achievement of learners receiving UDL instruction: A meta-analysis. Teaching and Teacher Education. 2023;122:103956.

[19] Craig SL, Smith SJ, Frey BB. Professional development with universal design for learning: Supporting teachers as learners to increase the implementation of UDL. Professional Development in Education. 2022;48(1):22-37.

[20] Rao K, Meo G. Using universal design for learning to design standards-based lessons. Sage Open. 2016;6(4):2158244016680688.

[21] Dewi SS, Dalimunthe HA. The effectiveness of universal design for learning. Journal of Social Science Studies. 2019;6(1):112-23.

[22] Moscato M, Pedone F. Enhancing inclusive teaching. A teacher professional development research grounded in UDL principles. Pedagogical perspective. 2024:110-25.

[23] Singh RKKC. Building Teacher Capacity for Inclusive Education: A Professional Development Model Using Technology and UDL. 2023.

[24] Cruz S, Maia M. From Curriculum for All to Inclusive Practice: Insights from a Pilot Study on UDL-Based Pedagogical Transformation. International Association for Development of the Information Society. 2025.

[25] Balcı M, Meylani R. AI and Assistive Technologies for Equitable and Inclusive Education: A Comprehensive Review of the Contemporary Research Literature. 2025.

[26] Latt KM. A Systematic Review of Universal Design for Learning in Inclusive Education. 2026.

[27] Mayasari LI, Dulyapit A, Yunitasari SE, Syam AR. INTEGRATING UNIVERSAL DESIGN FOR LEARNING AND DIGITAL TECHNOLOGY: ADVANCING INCLUSIVE EDUCATION IN THE 21ST CENTURY. Irfani. 2025;21(2):768-82.

[28] McCoy KM, Mathur SR. Differentiation in the digital-based classroom: A Universal Design approach for inclusive settings in middle schools. Journal of Education and Development. 2017;1(1):1-11.

[29] Priyadharsini V, Mary RS. Universal design for learning (UDL) in inclusive education: Accelerating learning for all. Shanlax International Journal of Arts, Science and Humanities. 2024;11(4):145-50.

[30] Veytia Bucheli MG, Gómez-Galán J, Cáceres Mesa ML, López Catalán L. Digital technologies as enablers of universal design for learning: higher education students' perceptions in the context of SDG4. Discover Sustainability. 2024;5(1):473.

[31] Hall TE, Cohen N, Vue G, Ganley P. Addressing learning disabilities with UDL and technology: Strategic reader. Learning Disability Quarterly. 2015;38(2):72-83.

[32] Koranteng U. Designing the AI-Inclusive Framework (AIF): Integrating Artificial Intelligence, Assistive Technology, and Universal Design for Learning in Inclusive Education. Assistive Technology, and Universal Design for Learning in Inclusive Education (October 17, 2025). 2025.

[33] Rawat S, Jain P, Saini AK. Designing UDL-Informed Online Learning with Digital Tools. 2024.

[34] Tshiovhe T, editor Innovative Teaching Strategies for Global Classrooms: Advancing Digital Equity and Global Partnerships in Higher Education. The Focus Conference (TFC 2025); 2025: Atlantis Press.

[35] Catama BV. Universal Design for Learning in action: Exploring strategies, outcomes, and challenges in inclusive education. International Journal of Rehabilitation and Special Education. 2025;5(2):6-12.

[36] Poggianti C, Chessa S, Pelagatti S, Kocian A. Immersive technologies for inclusive digital education: A systematic survey. Human Behavior and Emerging Technologies. 2025;2025(1):8888303.

[37] Han C, Lei J. Teachers' and students' beliefs towards Universal Design for Learning framework: A scoping review. Sage Open. 2024;14(3):21582440241272032.

[38] Mavrou K. The use of assistive technology in education: a guide for teachers and schools. Education Section, UNICEF Regional Office for Europe and Central Asia Preuzeto s https://www unicef org/eca/media/30671/file/Teacher's% 20guide% 20for% 20building. 2022;20.