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Toward an AI-Enhanced Universal Design for Learning Framework: A Theory-Synthesis Approach to Inclusive Education

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Abstract- Artificial intelligence (AI) is rapidly reshaping educational practice by enabling more personalized, adaptive, and accessible learning experiences. Despite these advances, there remains a limited pedagogically grounded understanding of how AI can be meaningfully integrated with Universal Design for Learning (UDL) to support inclusive education while preserving teacher agency, ethical responsibility, and learner diversity. Addressing this gap, this conceptual paper proposes the AI-Enhanced Universal Design for Learning (AI-UDL) Framework, developed through a theory-synthesis approach that integrates contemporary scholarship on UDL, AI in education, human-centered AI, and inclusive and special education. Drawing on this interdisciplinary synthesis, the framework conceptualizes AI as an instructional partner that supports, rather than replaces, teachers in designing flexible, equitable, and responsive learning environments. The AI-UDL Framework comprises six interrelated dimensions: learner profiling, adaptive representation, personalized engagement, flexible expression, teacher decision support, and ethical governance. Together, these dimensions demonstrate how AI can operationalize UDL principles while maintaining pedagogical integrity, accessibility, and human oversight. By reconceptualizing the relationship between AI and UDL, this paper advances a theoretically grounded framework that contributes to the emerging discourse on responsible AI integration in education. The framework offers practical guidance for educators, instructional designers, and policymakers and establishes a foundation for future empirical validation, instructional innovation, and the development of AI-supported inclusive learning environments.

Keywords- Artificial intelligence in education; Universal Design for Learning; AI-Enhanced Universal Design for Learning (AI-UDL); Inclusive education; Special education; Human-centered AI; Teacher decision support.

I. Introduction

Every classroom is, in practice, a room full of different learners meeting the same curriculum at the same time. That mismatch between a fixed curriculum and variable learners is the problem UDL was designed to solve, not by remediating the learner, but by redesigning the environment so that multiple pathways to engagement, representation, and expression are built in from the start (CAST, 2024). For nearly three decades, UDL has served special and inclusive educators as a proactive alternative to retrofitted accommodation, and its uptake has only grown under policy frameworks that treat inclusion as a design requirement rather than an afterthought.

What has changed in the last several years is not the logic of UDL but the toolset available to enact it. Generative and adaptive artificial intelligence systems can now produce multiple representations of the same content on demand, translate and simplify text in real time, generate practice items at varying difficulty, and surface patterns in learner performance that would take a human teacher considerably longer to notice (Mallary, 2025; Saborío-Taylor & Rojas-Ramírez, 2024). For a field that has always been constrained by the sheer labor of individualizing instruction for heterogeneous classrooms, and especially for classrooms that include students with intellectual disability, autism, specific learning disability, or sensory impairment, this is not a minor convenience. It is a genuine shift in what proactive, individualized design can look like at scale.

That shift, however, has arrived without a settled theoretical account of how AI and UDL should relate to one another. Much of the existing literature treats the two as separately beneficial: one stream documents what UDL is and why it matters (CAST, 2024; Ecker, 2023), and a second, rapidly growing stream documents what AI tools can technically do in classrooms (Song et al., 2024; Cheah et al., 2025). Comparatively little work has asked the more structural question of how AI's capabilities should be organized and governed so that they extend UDL's principles rather than quietly displacing the pedagogical judgment UDL was built to protect. Several recent papers gesture toward integration, describing AI as a "collaborative partner" across stages of adoption or cataloguing practical applications such as AI-generated rubrics and adaptive feedback (Mallary, 2025), but a structured, testable framework that names the components of that integration and specifies where teacher oversight sits within it remains underdeveloped.

This gap matters most acutely in special and inclusive education. Teachers working with students who have intellectual disability, autism spectrum disorder, or multiple disabilities already carry a heavier individualization burden than their general-education peers, and they are also working with a population whose data, behavior, and communication patterns are more likely to be misread by systems trained on typically developing samples (Baker & Hawn, 2022). Enthusiasm about AI's potential to personalize learning for students with disabilities is well documented (Paglialunga & Melogno, 2025), but so are warnings about algorithmic bias, opaque decision-making, and the erosion of teacher and learner agency when systems are adopted without a governing pedagogical framework (Akgun & Greenhow, 2022; Alfredo et al., 2024).

This is not a merely academic concern. Special education operates under legal and ethical commitments, individualized planning, least restrictive environment, informed parental consent, that were written for a world of human decision-makers. When an AI system quietly takes over part of the individualization work an IEP team is legally responsible for, without a framework specifying where its recommendations end and a teacher's or team's judgment must begin, those commitments do not automatically transfer to the new tool. They simply go unaddressed until a problem surfaces. The purpose of this paper is to close part of that gap. Using a conceptual research design grounded in theory synthesis, the paper develops AI-Enhanced Universal Design for Learning (AI-UDL), an original framework that positions artificial intelligence as a means of strengthening, rather than substituting, the professional judgment at the center of inclusive teaching. The paper proceeds in five parts. It first reviews the theoretical foundations the framework draws on: UDL, AI in education, human-centered AI, and AI in special education. It then describes the theory-synthesis methodology used to build the framework. It presents the AI-UDL framework itself, including its six components and their relationship to UDL's three principles. It discusses implications for teacher preparation and classroom practice, with particular attention to special education contexts. It closes with the framework's limitations and an agenda for its empirical validation.

II. Theoretical Background

1. Universal Design for Learning as a Proactive Framework for Variability

UDL rests on a premise that is easy to state and difficult to operationalize: learner variability is predictable, not exceptional, and curricula should be designed for that variability from the outset rather than adjusted for it after the fact (CAST, 2024). The framework organizes this design work around three principles, commonly summarized as the "why," "what," and "how" of learning: multiple means of engagement, multiple means of representation, and multiple means of action and expression (Song et al., 2024). Ecker (2023) frames UDL specifically as an infrastructure for learner-centered education, arguing that its value lies less in any single technique than in the discipline of building flexibility into the environment before a barrier is encountered.

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Two features of UDL are especially relevant to the present framework. First, UDL is explicitly proactive rather than reactive; it is a design stance, not a compensatory add-on for a subset of students (CAST, 2024). This distinguishes it from a purely accommodation-based model of special education, in which a standard lesson is delivered and then individually modified after a student struggles. UDL instead asks the designer to anticipate variability before the lesson is taught, which is precisely why it has found such a durable home in special and inclusive education: it reframes disability-related barriers as properties of an inflexible environment rather than deficits located solely within the learner. Second, UDL has always assumed a human designer, typically a teacher or instructional designer, translating its guidelines into concrete lesson decisions. The guidelines describe what flexibility should look like; they do not, and could not, specify how a busy classroom teacher generates three or four alternative representations of the same content for every lesson, every day, across a full academic year. That practical labor gap between UDL's ambition and a teacher's available time has historically limited how fully the framework is implemented in practice, even by educators who are fully persuaded of its value. Neither feature was written with AI in mind, and both are directly implicated once AI tools start generating the representations, pathways, and assessments that UDL calls for: the proactive stance becomes easier to sustain at scale, but the assumption of a human designer making the final call becomes something that has to be actively protected rather than simply inherited from the framework's original design.

2. Artificial Intelligence in Education: Capability Without a Settled Pedagogy

The literature on AI in education has expanded rapidly since roughly 2018, tracking the arrival of adaptive tutoring systems and, more recently, generative AI. Reviews of this literature converge on a consistent set of capabilities: content generation and simplification, adaptive sequencing of practice, automated formative feedback, and analytics that flag learners who may be falling behind (Cheah et al., 2025; Mallary, 2025). These capabilities map with unusual neatness onto UDL's three principles, which is precisely why researchers have begun to describe AI and UDL as natural partners: AI's capacity for content generation supports multiple means of representation, its adaptive sequencing supports multiple means of engagement, and its flexible output formats support multiple means of action and expression (Saborío-Taylor & Rojas-Ramírez, 2024; Song et al., 2024).

At the same time, this same body of research is candid about what remains unresolved. Chounta et al. (2022), studying K-12 teachers' perceptions of AI in an Estonian context, found that teachers were open to AI as a support for their practice but were wary of tools that reduced their own decision-making role. Bastani et al. (2025), in a randomized trial in high-school mathematics, found that generative AI used without pedagogical guardrails could measurably harm learning, a finding that complicates any assumption that more AI automatically means better personalization. Taken together, this literature supports a cautious conclusion: AI has clear technical capability to support UDL's aims, but capability alone does not guarantee sound pedagogy, and the difference appears to hinge on how AI is structured into the instructional decision, not merely whether it is present.

3. Human-Centered AI and the Question of Agency

A parallel literature on human-centered AI (HCAI) supplies the governing logic this paper leans on to resolve that tension. HCAI treats AI not as an autonomous decision-maker but as a system whose design should actively preserve and strengthen human capability, oversight, and accountability (UNESCO, 2022, 2023). Reviews of HCAI in education describe this as a matter of keeping a "human in the loop," ensuring that teachers retain interpretive authority over what AI systems surface, and treating transparency and explainability as design requirements rather than optional features (Alfredo et al., 2024; Amershi et al., 2019). Brod et al. (2023) go further, arguing that agency in educational technology is not simply about whether a student or teacher is given a choice, but about whether the system is structured in a way that supports meaningful, informed decision-making, a distinction that matters considerably once AI begins making recommendations about students who may not be able to self-advocate for the accuracy of those recommendations.

Ethical concerns sit close to the center of this literature and cannot be treated as a footnote. Baker and Hawn (2022) document how algorithmic systems in education can encode and amplify bias along lines of disability, race, and socioeconomic status, and Liang et al. (2023) show that even tools built specifically to detect AI-generated text are biased against particular language patterns, an issue with direct relevance to learners who communicate atypically. The Organisation for Economic Co-operation and Development (2024) has similarly flagged the risk of what it terms techno-ableism, in which AI systems calibrated to typical performance patterns misclassify or under-serve disabled learners precisely because the training data did not represent them. Any framework that brings AI into special and inclusive education has an obligation to build governance against these risks in from the start rather than treating them as issues to patch later.

4. AI in Special Education

The special education literature on AI is smaller than the general AI-in-education literature but has grown quickly. Systematic reviews report largely positive findings for AI-supported interventions with students with learning disabilities, particularly in dyslexia-related instruction (Paglialunga & Melogno, 2025), and broader syntheses describe consistent gains in engagement and access when AI-driven assistive technologies are paired with appropriate teacher support (Dumitru et al., 2026). These reviews also repeat a caution found throughout the wider literature: gains are conditional on thoughtful integration, teacher training, and ethical safeguards, not on the technology alone (Paglialunga & Melogno, 2025).

What is largely absent from this literature is a framework that connects these findings back to UDL as an organizing pedagogy, rather than treating each AI tool as a discrete intervention. Song et al. (2024) come closest with a framework for inclusive AI learning design that pairs UDL's three principles with practical design components, though their focus is on teaching AI content to K-12 students rather than on using AI to deliver UDL-aligned instruction across the curriculum. The present paper builds on that structural approach but shifts its object: rather than designing AI curricula inclusively, it asks how AI can be organized as an instrument of UDL-aligned teaching itself, with a governance layer explicitly built for the ethical stakes documented above.

This structural gap has a practical cost that is easy to underestimate. When AI tools are adopted one at a time, a speech-to-text tool here, an adaptive worksheet generator there, a district or teacher preparation program has no shared vocabulary for asking whether the resulting collection of tools adds up to a coherent instructional design or simply a pile of conveniences with no relationship to one another and no consistent oversight. A teacher may use one AI tool that generates simplified reading passages and another that produces adaptive math practice without either tool being aware of the learner profile the other is implicitly relying on, and without either tool being subject to the same disclosure or bias-review process. Special education, more than most areas of practice, already has a mechanism built for exactly this kind of coordination: the individualized education program, which exists precisely to hold multiple services, goals, and supports together under one accountable plan. A framework that connects AI tools back to UDL's principles, and back to that same tradition of individualized, documented, team-reviewed planning, gives special educators a way to evaluate new AI tools against a stable pedagogical standard rather than adopting each one on the vendor's own terms.

III. Methodology

1. Research Design

This study adopted a conceptual research design using a theory-synthesis approach to develop the AI-Enhanced Universal Design for Learning (AI-UDL) Framework. Conceptual research is appropriate when the objective is to advance theoretical understanding by integrating existing knowledge rather than testing hypotheses through empirical data collection. Theory synthesis enables researchers to identify relationships among established concepts, reconcile complementary perspectives, and construct an integrative framework capable of guiding future research and practice. Within educational technology, this approach has been widely used to develop conceptual models that address emerging educational challenges where empirical evidence is still evolving.

The present study sought to address a conceptual gap concerning the pedagogical integration of artificial intelligence (AI) within Universal Design for Learning (UDL). Although previous studies have examined AI in education, UDL, human-centered AI, and special education independently, few have synthesized these domains into a coherent framework capable of guiding inclusive instructional design. Consequently, a theory-synthesis approach was considered the most appropriate methodology because it facilitates interdisciplinary integration while providing a systematic foundation for conceptual framework development.

2. Literature Identification and Selection

The literature synthesis drew upon peer-reviewed journal articles, systematic reviews, theoretical papers, and internationally recognized policy documents published primarily between 2018 and 2026, with particular emphasis on studies published after 2022 to capture recent developments in generative AI. The review focused on four complementary knowledge domains: Universal Design for Learning, artificial intelligence in education, human-centered artificial intelligence, and special and inclusive education.

Literature was identified using combinations of the following search terms: Universal Design for Learning, artificial intelligence in education, generative AI, inclusive education, special education, human-centered AI, teacher agency, algorithmic bias, and educational technology. Priority was given to peer-reviewed publications that contributed theoretical, pedagogical, or empirical insights relevant to AI-supported inclusive education. Policy publications from organizations such as CAST, UNESCO, and the OECD were included because they provide internationally recognized guidance on inclusive education and responsible AI.

Studies were included when they addressed at least one of the four conceptual domains and contributed directly to understanding AI-supported inclusive learning or pedagogical design. Publications focusing exclusively on technical AI development without educational relevance, opinion articles lacking theoretical grounding, duplicate publications, and studies unrelated to inclusive education were excluded from the synthesis.

3. Theory-Synthesis Process

Framework development followed a systematic four-stage theory-synthesis process.

Stage 1: Conceptual Domain Identification. Four theoretical domains were identified as essential to the proposed framework: Universal Design for Learning provided the pedagogical foundation; AI in education contributed technological capabilities; human-centered AI informed principles of transparency, accountability, and teacher oversight; and special education literature contributed evidence regarding learner variability, accessibility, and ethical considerations.

Stage 2: Conceptual Analysis. Relevant literature was examined to identify recurring concepts, theoretical relationships, and unresolved issues across the four domains. Particular attention was given to areas where AI capabilities aligned with UDL principles, as well as points of tension related to teacher agency, algorithmic bias, accessibility, and ethical governance.

Stage 3: Conceptual Synthesis. Concepts identified across multiple domains were compared and clustered according to their theoretical relationships. A construct was retained as a framework component only when it consistently appeared across at least two conceptual domains, demonstrated clear relevance to UDL implementation, and contributed uniquely to inclusive instructional design without duplicating another construct.

Stage 4: Framework Construction. The retained constructs were synthesized into six interconnected components that collectively explain how AI can operationalize UDL principles while maintaining teacher agency, learner-centered practice, and ethical governance. Each component was explicitly aligned with the core principles of Universal Design for Learning to ensure conceptual consistency and pedagogical coherence.

4. Theoretical Validation

Because this study is conceptual rather than empirical, framework validation was undertaken through theoretical validation rather than statistical testing. The proposed AI-UDL Framework was evaluated against three complementary criteria. First, internal coherence was examined to determine whether relationships among the six framework components were logically consistent and mutually reinforcing. Second, theoretical consistency was assessed by examining the alignment of the framework with established principles of Universal Design for Learning, constructivist and sociocultural learning theories, and human-centered AI. Third, practical applicability was considered by evaluating whether the framework addressed the instructional, ethical, and accessibility challenges reported within contemporary special and inclusive education literature. This validation process ensured that the proposed framework was conceptually grounded while providing a robust foundation for future empirical investigation.

5. Trustworthiness

Although conceptual studies do not involve statistical reliability or participant validation, methodological rigor was strengthened through four complementary strategies. Theoretical triangulation was achieved by integrating evidence across the four conceptual domains rather than relying on a single body of literature. Conceptual coherence was maintained by ensuring that every framework component could be traced directly to multiple scholarly sources and established theoretical perspectives. Transparency was supported through explicit documentation of the literature selection, synthesis, and framework development procedures. Finally, transferability was enhanced by designing the AI-UDL Framework to inform instructional practice across diverse educational contexts, including special education, inclusive classrooms, teacher education, and higher education. Collectively, these strategies strengthen the credibility and scholarly integrity of the proposed framework while providing a transparent foundation for subsequent empirical validation.

IV. The AI-UDL Framework

1. Overview

AI-Enhanced Universal Design for Learning (AI-UDL) is organized around six interrelated components: Learner Profiling, AI-Driven Multiple Representation, Adaptive Engagement, Flexible Action and Expression, Teacher Decision Support, and Ethical and Inclusive Governance. The first four components correspond to the operational work of instruction, the fifth keeps a human educator interpretively central to that work, and the sixth wraps the entire framework in the safeguards the literature in Section 2.3 identifies as non-negotiable for disabled learners specifically. Figure 1 depicts the framework as a continuous cycle rather than a linear pipeline, because learner data, AI-generated adaptation, teacher judgment, and ethical oversight are meant to inform one another repeatedly across a unit of instruction, not run once in sequence.

Figure 1 AI-Enhanced Universal Design for Learning (AI-UDL) Framework

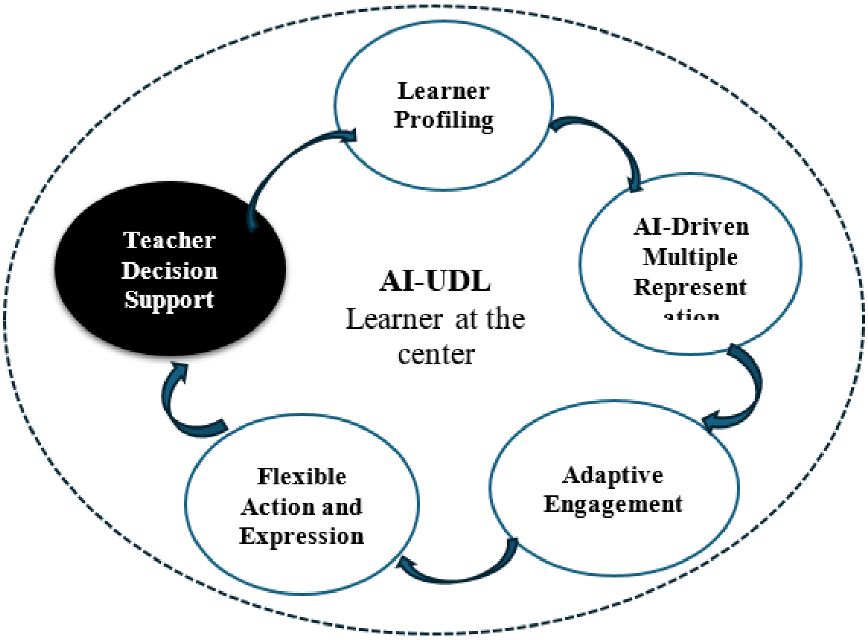

Figure 1 Note. Learner Profiling, AI-Driven Multiple Representation, Adaptive Engagement, Flexible Action and Expression, and Teacher Decision Support operate in a continuous cycle; Ethical and Inclusive Governance surrounds and constrains every component.

Figure 1 illustrates the AI-Enhanced Universal Design for Learning (AI-UDL) Framework as a dynamic, human-centered system for inclusive education. At the core of the framework are six interconnected components: Learner Profiling, AI-Driven Multiple Representation, Adaptive Engagement, Flexible Action and Expression, Teacher Decision Support, and Ethical and Inclusive Governance. The framework begins with understanding learner variability through AI-supported profiling, which informs the personalization of instructional content, engagement strategies, and opportunities for learners to demonstrate their knowledge. Teacher Decision Support ensures that AI-generated recommendations are interpreted through professional judgment, while Ethical and Inclusive Governance provides the overarching principles of transparency, fairness, privacy, accessibility, and accountability that guide every instructional decision. The continuous feedback cycle highlights the iterative nature of

AI-supported inclusive teaching, where learner outcomes inform ongoing instructional refinement and improvement.

2. Framework Components

Learner Profiling. This component uses AI to synthesize existing information about a learner, including present levels of performance, IEP goals, communication needs, and observed patterns of engagement, into a working profile that a teacher can review and correct. It corresponds to UDL's "why" of learning, since an accurate, teacher-verified profile is the precondition for engagement that is genuinely responsive to a given learner rather than generic (CAST, 2024). Critically, the profile is treated as a draft for teacher review, not a determination, given the documented risk that profiling systems trained on typical populations can misread the behavior of students with autism, intellectual disability, or communication differences (Baker & Hawn, 2022).

AI-Driven Multiple Representation. This component uses AI's generative capacity to produce the same content in multiple formats, simplified text, visual summaries, audio narration, translated versions, on a teacher's request, directly operationalizing UDL's principle of multiple means of representation (Song et al., 2024). The literature on AI-generated content adaptation in adult and higher education (Mallary, 2025) and in K-12 contexts (Cheah et al., 2025) both point to this as one of the more mature and lower-risk applications of AI in inclusive teaching, since the teacher remains the one selecting which representation a given learner needs.

Adaptive Engagement. This component uses AI to adjust the pacing, difficulty, and format of practice tasks in response to ongoing performance, aligning with UDL's principle of multiple means of engagement. The framework treats this component with more caution than representation, given evidence that adaptive systems deployed without pedagogical guardrails can reduce rather than improve learning outcomes (Bastani et al., 2025); accordingly, adaptive engagement in AI-UDL is bounded by teacher-set parameters rather than left fully autonomous.

Flexible Action and Expression. This component supports UDL's third principle by using AI to expand how learners can demonstrate understanding, through speech-to-text, symbol-based communication support, structured response templates, or alternative assessment formats, particularly relevant for learners with cerebral palsy, multiple disabilities, or limited expressive language. Reviews of AI-supported assistive technology in disability contexts report consistent gains in access and participation when these tools are matched carefully to individual need (Dumitru et al., 2026; Paglialunga & Melogno, 2025).

Teacher Decision Support. This is the component that keeps the first four operational components accountable to professional judgment rather than automated output. It presents AI-generated profiles, representations, engagement data, and expression options to the teacher as recommendations requiring review, not defaults requiring acceptance, echoing the "human-in-the-loop" principle central to human-centered AI (Alfredo et al., 2024; Amershi et al., 2019) and responding directly to teachers' documented preference to remain the interpretive authority in their own classrooms (Chounta et al., 2022).

Ethical and Inclusive Governance. This component is not a discrete instructional activity but a set of standing conditions that apply across the other five: routine auditing for bias in how the system treats learners with disabilities, transparency about what data is collected and why, informed involvement of families and, where appropriate, students in decisions about AI use, and clear limits on which decisions the system is permitted to make without teacher sign-off. It is grounded directly in the equity and bias literature reviewed in Section 2.3 (Baker & Hawn, 2022; Liang et al., 2023; OECD, 2024).

3. Mapping the Framework to UDL Principles

Table 1 summarizes how each AI-UDL component relates to UDL's three core principles and to its underlying pedagogical intent, making explicit that AI-UDL is not a parallel structure to UDL but an operational layer built on top of it.

Table 1: AI-UDL Framework Components Mapped to UDL Principles

AI-UDL Component	Primary UDL Principle	AI's Functional Role	Locus of Final Decision
Learner Profiling	Engagement (the "why")	Synthesizes existing learner data into a draft profile	Teacher confirms or corrects
AI-Driven Multiple Representation	Representation (the "what")	Generates alternative formats of the same content	Teacher selects representation
Adaptive Engagement	Engagement (the "why")	Adjusts pacing and difficulty within set bounds	Teacher sets bounds and reviews
Flexible Action and Expression	Action & Expression (the "how")	Expands response and communication modes	Learner chooses mode; teacher supports
Teacher Decision Support	Cross-cutting	Surfaces recommendations and evidence	Teacher retains interpretive authority
Ethical and Inclusive Governance	Cross-cutting	Audits, discloses, and constrains system behavior	Institution and IEP team oversight

Table 1 summarizes the six components of the AI-Enhanced Universal Design for Learning (AI-UDL) Framework and their respective pedagogical functions. For each component, the table identifies its primary purpose, the role of artificial intelligence in supporting inclusive instruction, its alignment with the corresponding Universal Design for Learning (UDL) principles, the responsibilities of teachers in maintaining human oversight, and the expected educational outcomes. Collectively, the table demonstrates how AI capabilities are integrated within a human-centered instructional framework that promotes learner variability, accessibility, engagement, equitable assessment, informed teacher decision-making, and ethical governance. Rather than presenting AI as an autonomous instructional system, the table reinforces the framework's central premise that effective AI-supported inclusive education depends on the complementary interaction between technological capabilities, pedagogical expertise, and responsible governance.

4. Theoretical Coherence

Checked against the theoretical touchstones identified in the methodology, AI-UDL holds together on three grounds. It preserves UDL's proactive design logic because each component operates before instruction is delivered or during it, not as a remediation applied afterward (CAST, 2024). It aligns with human-centered AI's insistence on retained human accountability because Teacher Decision Support and Ethical and Inclusive Governance are structural components, not optional add-ons, meaning the framework cannot be implemented correctly without them (UNESCO, 2022, 2023). And it responds directly to the special-education evidence base by building in the profiling caution, engagement bounds, and governance auditing that the disability-focused literature identifies as necessary, rather than importing a general AI-in-education model and assuming it transfers safely to disabled learners without modification (Baker & Hawn, 2022; OECD, 2024; Paglialunga & Melogno, 2025).

V. Discussion and Implications for Practice

1. Implications for Teacher Preparation

If AI-UDL has practical value, it is most likely to be felt first in special education teacher preparation, where pre-service teachers are already trained to think in terms of individualized profiles, present levels of performance, and legally mandated accommodation. AI-UDL gives that existing skill set a clear place to sit AI tools: pre-service teachers can be taught to treat AI-generated profiles, representations, and engagement data explicitly as drafts for professional review, which both builds appropriate skepticism toward AI output and models the exact human-in-the-loop stance the framework requires (Chounta et al., 2022). Teacher educators adopting the framework would need to teach two skills in tandem that are sometimes taught separately: the technical skill of prompting and evaluating AI tools, and the ethical skill

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of recognizing when an AI recommendation about a disabled learner needs to be questioned rather than trusted.

This has a direct implication for how self-directed learning is taught in teacher preparation programs themselves. Pre-service special educators are increasingly expected to learn with AI-assisted adaptive platforms as part of their own coursework, not only to learn about them. AI-UDL suggests that this self-directed use should be scaffolded the same way the framework scaffolds classroom use: pre-service teachers need explicit practice treating an AI-generated study plan, practice quiz, or feedback summary as a draft to evaluate against their own developing professional judgment, rather than as an authoritative output to accept. A teacher preparation program that lets candidates use adaptive AI tools without ever asking them to critique or correct those tools' output risks producing graduates who default to exactly the passive acceptance the framework is designed to prevent once they reach their own classrooms.

2. Implications for Classroom Practice

For practicing teachers, AI-UDL offers a way to sequence AI adoption rather than adopt it all at once. The framework's component structure suggests a natural order of implementation: representation-focused tools carry the least risk and can be adopted first, engagement and profiling tools require more caution and should be adopted with explicit bounds, and governance structures, audits, family communication protocols, disclosure practices, need to be in place before any of the higher-risk components are used with students, not retrofitted afterward. This sequencing responds directly to the finding that ungoverned adaptive AI can harm learning outcomes even when it is technically effective at personalization (Bastani et al., 2025).

3. Implications for Policy and Institutional Governance

At the institutional level, AI-UDL implies that inclusive-education policy needs to name AI governance explicitly rather than leaving it to individual teachers or vendors to define. This includes clarity about what learner data AI tools may access, mechanisms for families and IEP teams to question AI-informed recommendations, and routine auditing for disability-related bias of the kind documented in general AI systems (Baker & Hawn, 2022; Liang et al., 2023). Institutions already operating under legal frameworks that mandate individualized planning for students with disabilities have an existing structure, the IEP or equivalent process, into which this governance can be integrated rather than built from scratch. Where AI-generated recommendations are used at all in that process, the framework implies they should be entered into planning meetings labeled as AI-generated and open to challenge, in the same way a standardized test score is treated as one data point among several rather than a final determination.

4. Implications for Learner and Family Voice

A framework built around teacher oversight can, if it is not careful, still leave out the two people with the most at stake: the learner and the learner's family. AI-UDL's governance component is written to require their inclusion deliberately rather than treat "human-in-the-loop" as satisfied by teacher review alone. For learners old enough to participate in decisions about their own accommodations, this can mean being told, in accessible language, when an AI tool has generated part of a lesson or assessment they are completing, and being given a way to say that a particular representation or response mode is not working for them. For families, it can mean the same disclosure extended to IEP meetings, so that a parent evaluating a proposed goal or accommodation knows which parts of the recommendation came from a teacher's direct observation and which came from an AI system's synthesis of data. This is not a peripheral courtesy; it is a direct response to the finding that AI systems trained on typical populations are more likely to misjudge learners whose communication or behavior falls outside that typical range (Baker & Hawn, 2022), which means the people best positioned to catch such a misjudgment are often the learner and family themselves, not the system or even the teacher alone.

Limitations and Directions for Future Research

As a conceptual paper, AI-UDL has not yet been tested empirically, and that is its central limitation. The framework's components were derived through theory synthesis and are internally coherent with the literature they draw on, but coherence with existing theory is not the same as demonstrated classroom effectiveness. Future research should prioritize small-scale, mixed-methods pilot studies that examine how teachers actually use the Teacher Decision Support component in practice, whether the profiling and engagement components produce the intended gains without the harms documented elsewhere in adaptive AI research (Bastani et al., 2025), and whether the governance component is implementable within existing special-education legal and administrative structures rather than adding an unsustainable compliance burden. Comparative studies across disability categories would also help establish whether a single six-component framework is appropriate across the full range of intellectual, sensory, physical, and communication-related disabilities, or whether some components need category-specific elaboration. Finally, because this synthesis drew primarily on English-language and largely Western scholarship, future work should examine how well AI-UDL transfers to education systems, including those in South Asia, operating under different policy frameworks, resource conditions, and cultural expectations of teacher authority.

VI. Conclusion

Artificial intelligence has arrived in inclusive classrooms ahead of a settled pedagogy for using it well, and the risk in that gap runs in both directions: adopted without structure, AI can quietly narrow teacher judgment and misread the very learners inclusive education exists to serve; avoided out of caution, it leaves individualization exactly as labor-constrained as it has always been. This paper has argued that Universal Design for Learning already supplies the pedagogical logic needed to close that gap responsibly, and that what has been missing is a framework connecting UDL's principles to AI's capabilities in a way that keeps teacher judgment structurally central rather than optional. AI-Enhanced Universal Design for Learning (AI-UDL), built through theory synthesis across UDL, AI-in-education, human-centered AI, and special-education scholarship, offers one account of what that connection can look like: six components, four operational and two governing, organized so that AI extends what a teacher can see and offer a learner without displacing the judgment that decides what to do with it. Whether this particular framework proves durable is a question for the empirical research it is designed to invite; what this paper has tried to establish is that inclusive education needs frameworks of this kind now, built with the same deliberateness UDL itself was built with, rather than adopting AI tools one at a time and hoping a coherent pedagogy assembles itself afterward.

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