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Tailored Use Of Information And Communication Technologies (ICT) In Inclusive Education To Meet Students' Needs

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Abstract: Inclusive schooling requires not only physical access but also the systematic removal of learning barriers through pedagogical design and technology that respond to variability in learners' profiles. This study develops and evaluates a model for the tailored use of information and communication technologies (ICT) within an inclusive education framework. Grounded in Universal Design for Learning (UDL), the model aligns multiple means of representation, engagement, and action with individualized supports such as assistive applications, accessibility features, and learning analytics. A quasi-experimental, mixed-methods design was implemented over one semester in eight inclusive classes (N=184) in upper-secondary and early undergraduate programs. Baseline profiling combined functional needs screening, curriculum barrier analysis, and technology readiness, followed by co-designed learning plans that integrated text-to-speech, speech-to-text, captioning, screen readers, alternative input devices, structured note-taking, multimodal content, and analytics-driven feedback. Compared with control classes using generic ICT, the tailored condition showed significant gains in reading comprehension, written expression, task persistence, and self-efficacy, with pronounced effects for learners with sensory and language-based difficulties. Qualitative data from observations and learner journals indicated improved autonomy, reduced cognitive load, and clearer pathways for demonstrating mastery. The discussion elaborates design principles: begin from barriers rather than labels, integrate assistive and mainstream tools within UDL-aligned tasks, orchestrate formative feedback using analytics, and build teacher capacity for iterative re-tailoring. The study concludes that tailored ICT, when embedded in reflective pedagogy, is a practicable route to equitable learning outcomes and accountable inclusion.

Keywords: Inclusive education; Universal Design for Learning; assistive technology; accessibility; learning analytics; text-to-speech; speech-to-text; multimodal learning; self-efficacy; equitable assessment.

Introduction: The promise of inclusive education is frequently expressed as access, participation, and achievement for all learners within common learning environments. Realizing this promise requires pedagogical intentionality that anticipates variability and reduces barriers at their source rather than remediating learners after the fact. Information and communication technologies can function as amplifiers of inclusion when they expand the perceptual channels, response modalities, and motivational affordances through which learners engage with curriculum. The same technologies, however, can also reproduce inequities if deployed generically without regard to the specific barriers that distinct learners face. The tension between universal provision and individualized fit lies at the heart of effective ICT use in

inclusive education.

Universal Design for Learning provides a conceptual bridge between universality and individual tailoring. By designing for variability from the outset—through multiple means of representation, engagement, and action—UDL encourages teachers to orchestrate flexible pathways to mastery. Within such flexible designs, tailored supports remain necessary. A student with dyslexia may benefit from text-to-speech and controlled pacing; a student who is deaf or hard of hearing may require accurate captioning and visual signaling; a learner with motor impairments may need alternative input devices. Tailoring in an inclusive paradigm therefore does not signal departure from universalism; rather, it realizes universal intentions through concrete adjustments to remove barriers that persist even within well-designed lessons.

Despite the conceptual alignment, many schools implement ICT primarily as infrastructure rather than as pedagogy. Devices and applications are introduced with limited analysis of curriculum barriers or learner profiles, and assistive technologies are treated as separate from mainstream platforms. This separation burdens learners with additional interfaces, weakens assessment alignment, and leaves teachers uncertain about the evidence basis for selecting tools. Moreover, generic digital materials often overload working memory or rely on a single modality, compounding difficulties for students with language-based or attentional challenges. The present study addresses these practical disconnects by proposing a model that begins with barrier analysis, integrates assistive and mainstream ICT within UDL-aligned tasks, and uses learning analytics to drive formative adjustments.

Two research questions guide the inquiry. First, to what extent does a tailored ICT approach improve learning outcomes and engagement in inclusive classes relative to a generic ICT approach of comparable intensity? Second, how do students and teachers experience the fit between tools, tasks, and individual needs, and which mechanisms appear to mediate gains? By focusing on both outcomes and experiences, the study aims to illuminate not only whether tailored ICT works, but how and why it functions within ordinary classroom constraints.

The contribution is both practical and theoretical. Practically, the study offers an implementable workflow that schools can adopt without specialized hardware beyond what contemporary learning environments typically possess. Theoretically, it elaborates a view of inclusion as barrier-reduction through iterative design, positioning tailored ICT as a means for enacting equity rather than as a compensatory add-on. In doing so, it aligns with UDL's insistence on variability as the norm and on proactive design as the engine of access.

The study used a quasi-experimental design with mixed methods in eight inclusive classes across two institutions serving late secondary and first-year undergraduate students. Four classes (n=92) implemented the tailored ICT intervention and four matched classes (n=92) continued with generic ICT use characterized by standard digital textbooks, slide presentations, and a learning management system without systematic personalization. Classes were equivalent in subject area, teacher experience, and time on task. Ethical approval was obtained at the institutional level, and all participants and guardians where relevant provided informed consent. Data were anonymized and reported in aggregate.

The intervention followed a three-stage workflow. The first stage, profiling and barrier analysis, combined a short functional needs inventory, review of individualized education plans where applicable, and an audit of curriculum demands by unit. The inventory captured reading pace, decoding accuracy, auditory and visual preferences, fine-motor constraints, language proficiency, and attention regulation indicators. The curriculum audit identified linguistic complexity, symbolic density, motor requirements, and assessment response modes likely to create barriers. Teachers and a support specialist co-interpreted profiles to select candidate supports.

The second stage, co-design and integration, embedded supports into UDL-aligned tasks. Materials were prepared in parallel modalities: textual content was accompanied by audio via high-quality text-to-speech with adjustable rate and highlighting; videos were captioned with attention to domain-specific vocabulary; diagrams included alt text and interactive zoom; readings were chunked with clear headings and embedded glossaries; assignments permitted typed, dictated, or audio-recorded responses; structured digital organizers scaffolded note-taking and planning. Assistive applications such as screen readers, speech-to-text, and word prediction were configured on mainstream devices to minimize interface switching. Teachers explicitly taught students to select and calibrate tools based on task demands rather than identity labels, seeking to normalize tool choice as a strategic learning act.

The third stage, analytics-driven feedback, used data generated by the learning platform and assistive tools to adjust supports. Indicators included time-on-section, replays of audio or video, error rates in dictation, pause patterns in reading, and assignment completion

trajectories. Teachers held brief weekly conferences to review analytics alongside student self-reports, tuning settings such as speech rate, caption style, or planner granularity, and adjusting the difficulty of materials through alternative representations without altering core standards. Formative assessment rubrics attended to both content mastery and the quality of strategy use. Teachers in the control classes continued to use the same curriculum and schedule but without profiling, co-designed supports, or analytics review.

Outcome measures were collected at baseline and post-intervention. Reading comprehension used expository passages aligned with course topics and included literal and inferential items scored by standardized rubrics. Written expression was assessed through course essays evaluated blind on organization, coherence, and conventions. Task persistence was measured as the proportion of assigned activities completed within deadline windows, corroborated by platform logs. Self-efficacy employed a validated academic self-efficacy scale adapted for technology-supported learning, with internal consistency checked via Cronbach’s alpha. Qualitative data derived from structured classroom observations, teacher reflection memos, and student learning journals prompted to comment on tool fit, workload, and perceived autonomy. Data analysis used ANCOVA controlling for baseline scores to estimate intervention effects, and thematic coding to identify mechanisms of impact.

The tailored ICT condition outperformed the generic ICT condition on all primary outcomes after controlling for baseline differences. In reading comprehension, the adjusted mean gain corresponded to a moderate effect, with the largest advantages on inferential questions that required integrating textual and visual cues. Observational notes suggested that synchronized highlighting in text-to-speech supported parsing complex sentences, while captioned videos facilitated retrieval of technical vocabulary during discussion. Students who previously skipped dense readings were more likely to complete them when audio pacing could be lowered and when headings segmented content into digestible units.

Written expression improved in organization and clarity for students in the tailored condition, with effects most pronounced among learners with language-based difficulties. Speech-to-text reduced bottlenecks in drafting, enabling students to externalize ideas rapidly before revising with targeted teacher feedback. Word prediction increased lexical variety without inflating error rates when combined with explicit teaching on proofreading strategies. Teachers reported that structured planning templates embedded within the learning platform helped students maintain argumentative focus, resulting in essays with clearer thesis development and evidence integration.

Task persistence, measured as timely completion of activities, increased in the tailored classes. Platform logs showed steadier engagement curves across units rather than the sharp drop-offs common in the comparison classes following challenging assignments. Analytics-informed micro-adjustments appeared to play a role; when logs indicated repeated rewinds on a particular video segment, teachers inserted a short annotated version with key frames emphasized, and subsequent patterns showed fewer rewinds and faster progression. Students described feeling less overwhelmed because the environment offered legitimate options for approaching the same task through different modalities, which reduced avoidance behaviors.

Self-efficacy scores rose more in the tailored condition, with journals documenting a shift in learners’ narratives from deficit-framed to strategy-framed explanations of performance. Rather than attributing difficulty to personal incapacity, students referenced controllable factors such as adjusting speech rate, switching to dictation for brainstorming, or using a graphic organizer before drafting. Teachers corroborated these shifts, noting more precise help-seeking and greater willingness to attempt extended tasks.

Subgroup analyses indicated that learners with sensory and language-based needs experienced the largest gains, but benefits extended across the class. Students without formal labels reported that captions improved note accuracy and that audio supports were useful during commutes. Importantly, no significant penalty in content coverage was detected in the tailored classes; the pacing plan remained aligned to the syllabus because the time invested in profiling and co-design was offset by smoother task completion and reduced remediation after assessment checkpoints.

Thematic analysis of qualitative data highlighted mechanisms likely responsible for the observed gains. Reduction in extraneous cognitive load emerged as a recurrent theme; by aligning modality and pacing to individual profiles, the tailored environment freed working memory for comprehension and reasoning rather than for decoding. A second mechanism involved increased transparency of expectations through multimodal exemplars and rubrics, which made criteria for success observable and actionable. A third mechanism was motivational: choice among legitimate pathways fostered a sense of control and competence, which reinforced persistence. Finally,

normalization of assistive tools within mainstream platforms reduced stigma and encouraged peer collaboration around strategy rather than around identity categories.

The findings support the claim that tailored ICT, when embedded within UDL-aligned pedagogy, can produce measurable improvements in both academic outcomes and learner agency in inclusive classes. The contrast with generic ICT use suggests that technology intensity alone is insufficient; what matters is the fit between tool affordances, task demands, and individual profiles. Beginning with barrier analysis reframes inclusion as a design problem rather than a remediation problem, enabling teachers to select tools based on the kinds of processing they support rather than on categorical labels attached to students. This shift explains why effects generalized across the class and not only to those with formally documented needs.

Integrating assistive and mainstream tools within common platforms proved critical. When screen readers, dictation, captioning, and structured organizers are accessible from the same environment as the curriculum, students can fluidly switch strategies without logistical friction. Such integration also allows assessment to remain aligned with content standards because response options are accommodated without altering the construct being measured. The study's analytics-driven feedback loop illustrates how digital environments can support responsive pedagogy: unobtrusive data provide early signals of friction points, enabling teachers to adjust representations or scaffolds before disengagement takes hold.

The improvements in self-efficacy are particularly important for sustainable inclusion. Self-efficacy influences choice of tasks, persistence under difficulty, and resilience after setbacks. Tailoring that visibly connects strategies to performance appears to strengthen efficacy beliefs by making success pathways concrete. When students attribute progress to modifiable strategies rather than to fixed traits, they are more likely to continue experimenting with supports and less likely to internalize failure as identity. This motivational dynamic likely amplified the academic effects observed.

Several cautions follow from the study. First, tailored ICT is not a substitute for high-quality instruction; it is a set of tools and processes that amplify pedagogical intent. Without attention to disciplinary thinking, clear learning goals, and explicit strategy instruction, technology can become a superficial layer. Second, schools must invest in teacher capacity to conduct barrier analysis, configure tools, and interpret analytics ethically. Professional learning should model the very UDL principles teachers are asked to implement, offering multiple entry points and hands-on calibration with authentic student work. Third, privacy and data governance demand careful protocols; analytics must be used for formative support, not surveillance, and students should understand how their data inform decisions.

Limitations temper the interpretation of the results. The quasi-experimental design does not eliminate selection effects, and the semester time frame restricts claims about long-term maintenance or transfer to high-stakes examinations. Measures of reading and writing, while aligned to course content, may not capture broader competencies such as collaboration or problem solving. Future research should employ randomized designs where feasible, track outcomes across academic years, and extend the model to other subjects and age groups, including early grades where foundational language skills are still developing.

Notwithstanding these limitations, the study aligns with a growing body of evidence that inclusive pedagogy benefits from a synthesis of universal design and individualized supports. Tailored ICT operationalizes this synthesis by making variability visible and malleable in everyday practice. When teachers treat technology selection as hypothesis testing—choosing tools because they are likely to remove a specific barrier for a specific task, then checking evidence and revising—the classroom becomes a site of design inquiry. In such a culture, inclusion is not a static compliance goal but a continuous improvement process oriented to equity.

Tailored ICT use within a UDL-aligned framework enhances access, engagement, and achievement in inclusive classrooms by removing specific barriers while preserving common learning goals. Through profiling, co-design, and analytics-driven feedback, teachers can integrate assistive and mainstream tools so that students exercise agency over modality, pacing, and expression. The resulting gains in comprehension, written expression, task persistence, and self-efficacy suggest that technology, when guided by reflective pedagogy, can convert variability from a source of inequity into an engine of learning. Scaling this approach requires investment in teacher expertise, careful attention to ethics and data privacy, and institutional commitment to iterative design. With these conditions, tailored ICT becomes not an accommodation of last resort but a first-line strategy for delivering on the promise of inclusion.

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