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Designing Educational Technologies for Absenteeism: Iterative Development of an Inclusive Language-Learning Platform

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ABSTRACT

Purpose: This study reports the iterative design of a learning platform addressing structural absenteeism at a Moroccan open-access university, examining how design decisions aligned with Universal Design for Learning (UDL).

Approach: Following a design and development research (DDR) logic with ADDIE stages, a platform was deployed to 353 students and revised across four phases over one semester, each informed by the preceding one.

Findings: Personalised learning paths and simplified navigation (phase 2), progress visualisation and collaborative tools (phase 3) accounted for the largest engagement shifts.

These decisions advanced representation, action/expression and engagement, though accessibility features for sensory and motor disabilities remained absent throughout.

Implications: The findings illustrate a shift from builder-centred to user-centred design, offer a transferable account of what iterative design can achieve for engagement, and specify what UDL-compliant redesign would still require.

Keywords: design and development research; iterative design; open-access higher education; platform design; universal design for learning.

1. Introduction

Open-access universities in Morocco, as in much of the Global South, face a structural form of absenteeism that is rarely of the learners' own choosing. At the Faculty of Letters and Human Sciences of Agadir, of 346 students formally enrolled in a Didactics of Languages and Cultures module, only around 140 attended face-to-face sessions, a participation rate of roughly 40%. The gap is not explained by disengagement: students hold jobs alongside their studies, commute long distances, and contend with lecture halls that exceed their intended capacity. For these students, a digital learning environment is not a supplement to the course; it is, in practice, their principal point of access to it.

Designing for this population raises a question that is conceptual as much as technical: what does it mean to design a platform for a learner population defined by variability in circumstance rather than by a single, imagined 'typical' user? Universal Design for Learning (UDL) answers this question at the level of principle, holding that curricula should offer multiple means of representation, action and expression, and engagement, precisely because learner variability is the norm rather than the exception (Rose & Meyer, 2002, 2007). What UDL specifies less precisely is how such principles are actually approximated across a real, resource-constrained, iterative development process — where they are honoured, where they are compromised, and why.

This article addresses that gap by documenting the design and development of StudySmartly, a learning platform built for the population described above and revised across four successive phases over one semester. Two research questions guide the account. RQ1: Which design decisions, across four iterative phases, were associated with the largest shifts in student engagement? RQ2: How do these decisions align with — and depart from — the three principles of Universal Design for Learning? The purpose is not to evaluate the platform's learning outcomes, which are reported elsewhere from the

same fieldwork, but to document the design process itself as a case of evidence-informed iteration, in a genre — design and development research — that remains comparatively rare in accounts of higher-education platforms in the Global South.

2. Literature Review

Design and development research (DDR) is concerned with producing and documenting the process by which an educational artefact is built, rather than only evaluating its effects once built (Richey & Klein, 2007). Two features distinguish DDR from a conventional intervention study: the design itself is treated as the object of inquiry, and the account of its evolution — including the reasoning behind revisions — is considered a contribution in its own right, not merely a methods section. Reports of this kind remain comparatively rare for higher-education platforms outside well-resourced institutions, where design decisions are more often reported as fixed specifications than as a documented, evidence-responsive process.

The instrumental approach offers a complementary lens for interpreting what happens once a designed artefact meets its users. A technology is not simply adopted; it undergoes a double process in which the designer's intentions are inscribed in the artefact (instrumentalisation) and the user reconstructs the artefact into a genuine instrument for their own action (instrumentation) (Rabardel, 1995; Béguin & Rabardel, 2000). Empirical work on higher-education technology confirms that students routinely repurpose tools in ways that depart from designers' intentions, developing uses that reflect their own needs rather than the platform's original specification (Selwyn, 2016). This has a direct implication for design research: a platform's specification sheet describes only half of what the platform becomes once it is used, and a design account that stops at specification tells an incomplete story.

Universal Design for Learning translates this variability into a design mandate. First articulated by Rose and Meyer (2002), UDL holds that barriers to learning are located in inflexible materials and methods as much as in learners themselves (Rose & Meyer, 2007), and prescribes three principles: multiple means of representation (varied formats — text, audio, video, infographics — for content), multiple means of action and expression (varied ways for learners to demonstrate what they know), and multiple means of engagement (varied ways of sustaining interest and motivation, including choice and gamification) (Rao & Meo, 2016; Ralabate, 2011; Basham et al., 2013). Applied to e-learning specifically, UDL principles have been associated with improved accessibility, better accommodation of cultural diversity, and more

personalised learning pathways, particularly when combined with adaptive technologies capable of adjusting content in real time (Iniesto et al., 2016; Liu et al., 2010; Truong, 2016; Holmes et al., 2022).

Accessibility standards add a further, more codified layer to this picture. The Web Content Accessibility Guidelines (WCAG) provide the reference framework against which the accessibility of educational platforms is typically assessed, and studies applying WCAG to large-scale online courses have repeatedly found that platforms fall short of full compliance, particularly for multimedia content and interactive assessment (Sanchez-Gordon & Lujan-Mora, 2016; Acosta & Lujan-Mora, 2017). A systematic review focused on learners with cognitive impairments goes further, arguing that accessibility is not reducible to technical conformance and should instead be approached through UDL as a pedagogical, not merely technical, design principle (Cinquin et al., 2019) -- a claim this study's findings are positioned to test empirically rather than assume.

A tension nonetheless runs through this literature, one this article treats as a starting hypothesis rather than resolves by assertion. Much of the applied UDL literature focuses on accessibility for learners with disabilities — assistive technologies, screen readers, alternative interfaces (Laabidi et al., 2014; Kent et al., 2018). Yet the population most visible in open-access, high-absenteeism contexts is defined less by disability than by circumstantial variability: divided attention, irregular access, competing obligations. Whether iterative, feedback-driven design — without disability-specific accessibility engineering — can nonetheless approximate UDL's engagement and representation principles is an open empirical question, and one this design account is positioned to inform, precisely because accessibility features were not part of the platform's original specification.

3. Materials and Methods

This study adopts a design and development research approach structured around the ADDIE stages — analysis, design, development, implementation, evaluation — applied iteratively rather than as a single linear pass, together with a shift in design logic that the platform's development team explicitly named at the outset: moving from *maîtrise d'œuvre* (a builder-centred logic, where specifications are fixed in advance by the design team) to *maîtrise d'usage* (a user-centred logic, where specifications evolve in response to observed and reported use). The evidentiary base for each design decision reported below consists of platform interaction data (analysed via SQL queries and Python scripts, as detailed below) and qualitative feedback gathered through

semi-structured interviews and a focus group conducted with platform users during phases 3 and 4.

3.1. Setting and Participants

The study was conducted at the Faculty of Letters and Human Sciences of Agadir, Ibnou Zohr University, an open-access institution whose student body is drawn from across southern Morocco. Participants were students enrolled in the Didactics of Languages and Cultures module, taught in the sixth semester of the Bachelor's degree in French language and literature and directed by the module's instructor, co-author of the platform. Of 353 students who registered on the platform, 122 were active users. The cohort was predominantly female (approximately 68%), aged mainly 21 to 25, and universally equipped with a smartphone or computer; prior experience with learning platforms was self-rated at a mean of 3 out of 5.

3.2. The Platform: StudySmartly

StudySmartly was developed by the two authors, built on the Laravel (PHP) framework with a relational database, and structured around three access levels — administrator, instructor and student. The administrator interface centralises content validation, user management, performance analytics and platform configuration, reflecting a socio-constructivist design intent: decisions are meant to be informed by visible, continuously updated data rather than fixed once at launch. In its baseline specification, the platform combined algorithmic recommendation (content suggestions based on learner profile and history), formative assessment mechanisms (badges, progress dashboards, multimodal feedback), systematic trace collection, and collaborative spaces (thematic forums, shared workspaces, peer review). Table 1 summarises the platform's baseline functional specification across six dimensions.

Table 1. Baseline functional specification of StudySmartly.

Dimension	Specification
Algorithmic systems	Recommendation engine based on learner profile and history; personalised pathway adaptation; predictive flagging of potential difficulty
Assessment mechanisms	Integrated formative evaluation; badges and rewards; personal progress dashboard; multimodal (text, visual, audio) feedback
Data collection	Systematic, real-time trace collection (time on task, resources accessed, contributions, results); secured storage with partial anonymisation for aggregate analysis
Collaborative dimensions	Thematic discussion forums; shared project workspaces; collaborative wiki; peer-review mechanism
Accessibility	Responsive design across devices; partial WCAG compliance; adjustable font size and contrast; multilingual interface (Arabic, French, English)
Pedagogical orientation	Socio-constructivist approach; project-based activities; personalisable pathways; continuous, feedback-rich assessment

3.3. Iterative Development Procedure

The platform was revised across four phases over one semester, each phase informed by the analysis of the preceding one. Table 2 summarises the design decisions taken at each phase and the rationale documented for each.

Table 2. Design decisions and rationale across four development phases (17 March to 14 May 2024).

Phase	Window	Design decisions	Rationale
1 — Baseline	17 Mar-18 Apr (33 days)	Platform deployed as specified in Table 1; no revisions yet made	Establish an observational baseline; no prior data existed to justify any adjustment

2 — First adaptation	19-29 Apr (11 days)	Interactive quizzes and online assignments added; online content explicitly aligned with the face-to-face syllabus; forum ‘like’ and comment functions added; individual progress dashboard introduced	Diagnostic data from phase 1 (Table 3) identified onboarding failure and content misalignment as the two most tractable barriers; the ADDIE cycle was re-entered on this basis
3 — Structured autonomy	30 Apr-10 May (11 days)	Forum reorganised into categorised discussion threads; peer-assessment mechanism implemented; dedicated virtual spaces for collaborative projects introduced	Phase 2 data suggested unrealised potential for student autonomy; ADDIE was combined with grounded-theory constant comparison to let phase 2 patterns inform phase 3 design directly
4 — Intelligent personalisation	10 May-end of semester	Context-aware recommendation engine (browsing history, thematic and interpersonal affinity matching); personalised interface with dynamic content hierarchisation; advanced analytics for monitoring interaction structures	Consolidate phases 2-3 gains by shifting from manually structured affordances (categories, fixed dashboards) to algorithmically adaptive ones

Interaction data were extracted from the platform's relational database through SQL queries joining user, resource, session and interaction entities, and processed in Python (Pandas, NumPy) to compute access frequency, engagement duration and completion rates. Semi-structured interviews (n=15, purposively sampled across three performance bands) and a focus group (n=7, spanning ages 21 to 33 and including both full-time and working students) were conducted during phases 3 and 4 and analysed thematically in NVivo. Engagement was classified per phase into four profiles — highly active, regular,

selective, minimalist — by cross-tabulating forum participation, quiz completion and assignment submission; full distributional results are reported elsewhere from the same fieldwork and are drawn upon here only to characterise which design decisions preceded which shifts.

4. Results

4.1. Phase 1: Establishing the Baseline

The initial deployment served its diagnostic purpose, and the diagnosis was more specific than an aggregate engagement figure conveys. Of 122 active students, 53 (43.4%) never crossed the three-minute connection threshold used to define a meaningful session; these students were, in the design team's own terms, statistically 'invisible' in the platform's access metrics even though they had formally registered. Table 3 reproduces the diagnostic framework the design team used to interpret this gap between registration and engagement.

Table 3. Diagnostic analysis of phase 1 disengagement.

Dimension	Finding
Scale	53 of 122 active students (43.4%) never exceeded the 3-minute connection threshold defining a meaningful session
Statistical implication	These students were absent from all subsequent engagement metrics, which tracked only 69 users; the true onboarding failure rate was therefore larger than later analyses could capture
Interpretation	Close to half of registered students did not clear an initial engagement threshold, suggesting an entry barrier distinct from sustained-engagement barriers addressed by later design work
Questions raised	What barriers operate at first contact? How can first-time use be better supported? What mechanisms would encourage early engagement specifically, as opposed to sustained engagement?

This diagnosis reframed the design problem in a way that a bare engagement percentage would not have. Ergonomic friction and the absence of content-course alignment (the platform's materials had not yet been mapped onto the face-to-face syllabus) were identified as the two most tractable barriers, and it is specifically onboarding failure -- not low engagement in general -- that phase 2 was designed to address. Neither barrier had been anticipated at the specification stage; both emerged only once real users interacted with the baseline

design, illustrating a limit inherent to a builder-centred (*maîtrise d'œuvre*) approach taken alone.

4.2. Phase 2: From Builder-Centred to User-Centred Design

The second phase marks the platform's first explicit shift toward *maîtrise d'usage*, and its three design axes responded point by point to the phase 1 diagnosis. Content enrichment (interactive quizzes, online assignments, and explicit alignment of online material with the face-to-face syllabus) addressed the content-relevance gap; forum improvements ('like' and comment functions) lowered the threshold for a first, low-stakes interaction, directly targeting the onboarding failure Table 3 identified; and an individual progress dashboard gave returning students a visible record of their own activity. Over the ten-day observation window that followed deployment (19-29 April), Python analysis of 87 distinct users recorded 413 total accesses, with a distribution as skewed as the underlying engagement profiles: 25 users logged only a single access while two users logged eleven each. This phase coincided with the sharpest behavioural shift recorded across the four phases: minimalist profiles fell from 81.8% to 28.9%, while selective profiles rose from 6.6% to 48.8% and highly active profiles more than tripled to 15.7%. The co-occurrence of this shift with a redesign that targeted onboarding specifically is consistent with — though does not in isolation establish — a causal link between the phase 2 changes and engagement mobility; the point is returned to in the Discussion.

4.3. Phase 3: Supporting Self-Regulation

Phase 3 targeted a different layer of the platform: not entry barriers, as in phase 2, but the conditions for sustained, self-directed engagement. The design team combined the ADDIE cycle with grounded-theory constant comparison for this phase specifically, using phase 2 patterns to inform phase 3 design directly rather than waiting for a full cycle to close. Three structural changes followed: the forum was reorganised into categorised discussion threads (replacing the undifferentiated stream of phase 2); a peer-assessment mechanism was implemented; and dedicated virtual spaces were created for collaborative projects. Comment volume rose from 1,276 in phase 2 to 1,543 in phase 3 (+20.9%), generated by a near-identical pool of active contributors (40 in phase 2, 41 in phase 3) — indicating that the gain was driven by intensified engagement among returning users rather than by a larger user base. This is itself a design-relevant distinction: phase 2's interventions had recruited a base of engaged users; phase 3's interventions deepened that engagement rather than broadening it further.

This phase also marks the first point in the study at which qualitative data collection — interviews and a focus group — ran in parallel with quantitative monitoring. The qualitative material documented a diversification of engagement strategies: some students adopted highly autonomous, self-directed patterns, while others favoured the newly collaborative, peer-oriented affordances. This diversification is itself a design-relevant finding: it suggests that phase 3's dual investment — in categorisation and structure on one hand, peer collaboration on the other — served two distinct emerging needs rather than a single one, which a narrower design choice at this stage might have missed.

4.4. Phase 4: Consolidation

Contrary to the pattern in phases 2 and 3, phase 4 introduced a structurally different kind of feature: rather than adding manually structured affordances (a category, a dashboard, a dedicated space), it shifted decision-making toward the algorithm itself. A context-aware recommendation engine was introduced, using browsing history to suggest content and to identify thematic and interpersonal affinities between students, actively proposing connections between learners who shared interests; the interface was reorganised around dynamic content hierarchisation rather than a fixed structure; and analytics tools were added specifically to monitor interaction structures and map emerging learning networks. This marks a qualitative shift in the design logic itself, from the team manually structuring the environment (phases 2 and 3) to the environment adapting itself to observed behaviour (phase 4) -- the clearest instance in this dataset of the *maîtrise d'usage* logic reaching its fullest expression.

The final engagement distribution -- 25% highly active, 28% regular, 32% selective, 15% minimalist -- retained all four profiles rather than converging on one, which the design team interprets as evidence that the platform came to accommodate several legitimate modes of engagement rather than optimising for a single normative one. Individual trajectories bear this out at the extremes: one student who had contributed only once in phase 1 and twice in each of phases 2 and 3 produced 205 comments in phase 4 alone -- 29.4% of that phase's total -- illustrating how the recommendation engine's affinity-matching could convert a previously marginal user into the platform's most active contributor within a single phase. Qualitative reports at this stage also documented improved conceptual understanding and emerging metacognitive behaviour among frequent users, though this study's design does not permit attributing these gains to the platform independent of students' concurrent face-to-face instruction.

4.5. Mapping Design Decisions onto UDL Principles

Table 4 maps the design decisions taken across the four phases onto the three UDL principles, distinguishing decisions that substantively advanced a principle from aspects that remained unaddressed throughout the development process.

Table 4. Design decisions mapped onto UDL principles.

UDL principle	Decisions advancing this principle	Gaps remaining at phase 4
Multiple means of representation	Multimodal feedback (text, visual, audio); progress visualisation (phase 3); multilingual interface (Arabic, French, English)	No screen-reader-tested alternative text; no captioning for multimedia content
Multiple means of action and expression	Personalised pathways (phase 2); collaborative tools allowing project work, discussion and peer review (phase 3)	Assessment formats remained limited to quizzes and written assignments; no alternative modes (oral, project-based) built into the platform itself
Multiple means of engagement	Simplified navigation and stronger feedback (phase 2); personalised recommendation and collaborative spaces (phase 3); badges and progress dashboards (baseline)	Gamification elements (badges) were present from baseline but not iterated on or evaluated across phases

The pattern in Table 4 is informative in what it shows as much as in what it shows missing. Iterative, feedback-driven design substantially advanced the engagement principle and made meaningful progress on representation and action/expression — but did so without any disability-specific accessibility engineering, confirming that the two are empirically separable: a platform can become markedly more UDL-aligned in its engagement and representation affordances through ordinary iterative development, while remaining without the assistive-technology compatibility (screen readers, captioning) that full UDL compliance requires. WCAG compliance, noted as 'partial' in the baseline specification (Table 1), remained partial through phase 4.

5. Discussion

5.1. From Specification to Use: What Iterative Design Achieved

The design decisions documented here trace a recognisable arc from *maîtrise d'œuvre* to *maîtrise d'usage*. Phase 1 specified a platform from design-team intentions; phases 2 through 4 progressively rewrote that specification in response to observed and reported use — precisely the double movement of instrumentalisation and instrumentation that the instrumental approach predicts (Rabardel, 1995; Béguin & Rabardel, 2000). The ergonomic obstacles and personalisation gap identified only once real students used the baseline platform illustrate a limitation inherent to specification-first design: some barriers are not visible to a design team until an artefact meets a population whose circumstances the team can approximate but not fully anticipate.

The temporal association between phase 2's redesign and the sharpest engagement shift recorded across the study — minimalist profiles falling by more than fifty percentage points, highly active and selective profiles both rising sharply — is the most direct evidence this design account offers that pathway personalisation and interface simplification mattered. The association should be read with appropriate caution: phase 2 also coincided with several weeks of platform familiarisation, and the two influences cannot be fully separated with the present design. What can be said with more confidence is the qualitative pattern documented in phase 3 — the diversification of engagement strategies following the introduction of both individual-progress and collaborative tools — which suggests that offering multiple, simultaneous avenues for engagement served genuinely different student needs, an observation more directly attributable to the design decisions themselves than the phase 2 shift is.

5.2. What Remained Outside the Iterative Process

The UDL mapping in Table 4 identifies a boundary that four phases of user-responsive iteration did not cross. Feedback-driven design, however attentive, surfaces the needs that are voiced or behaviourally visible in the available data; it does not reliably surface the needs of learners whose barriers require accessibility engineering the platform was never instrumented to detect — screen-reader compatibility, captioning, alternative input methods. No interview or focus-group participant raised disability-specific accessibility as a concern, but the sampling and recruitment for those instruments were not designed to reach learners for whom such barriers would be most salient, and their absence from the data cannot be read as absence of need. This is not a failure

specific to this platform; it is a structural limitation of iteration driven by majority-usage signals, and it is precisely the limitation that dedicated UDL accessibility engineering — as distinct from general responsive design — exists to address (Laabidi et al., 2014; Kent et al., 2018).

5.3. Implications for Design Practice

Three implications follow for teams designing learning platforms in comparable open-access, high-absenteeism contexts. First, a documented, iterative DDR process is itself a transferable contribution, independent of the specific platform built: the sequence baseline diagnosis (phase 1) to targeted correction (phase 2) to depth and differentiation (phase 3) to consolidation (phase 4) offers other design teams a template for sequencing their own iterations, and for deciding what kind of evidence to collect at each stage. Second, engagement-oriented iteration and accessibility engineering are not the same work and should not be assumed to converge: teams aiming for genuine UDL compliance should budget for accessibility auditing and assistive-technology testing as a distinct design activity from the start, rather than expecting it to emerge from general usage-responsive design. Third, retaining diversity in the final engagement distribution — rather than treating a single dominant profile as the design target — may itself be a marker of successful UDL-oriented design: a platform that accommodates highly active, regular, selective and minimalist engagement simultaneously is arguably closer to the UDL ideal of multiple legitimate pathways than one that converges all users onto a single normative pattern of use.

5.4. Limitations and Future Research

Three limitations bound these findings. The design account rests on a single platform, cohort and institution; the sequencing of design decisions reported here is a case, not a general recipe, and its transferability to other open-access contexts remains to be tested. The temporal association between design decisions and engagement shifts, most consequentially at phase 2, cannot be disentangled from concurrent familiarisation effects with the present single-arm design; a stepped-wedge or comparison-cohort design, feasible now that the platform is stable, would allow this separation directly. Finally, the absence of disability-specific accessibility findings reflects a genuine gap in the platform and in the study's data-collection instruments alike, not evidence of an absence of need; a dedicated accessibility audit, including direct engagement with learners who use assistive technologies, is the necessary next step and is not one this design account was positioned to take. Future design cycles should treat that audit as a distinct phase five, evaluated

against WCAG criteria directly rather than inferred from general usage patterns.

6. Conclusions

This study documented the iterative design of a learning platform built to serve students for whom structural absenteeism makes digital access a necessity rather than a supplement, and asked which design decisions, across four phases, were associated with the largest shifts in engagement, and how those decisions aligned with the principles of Universal Design for Learning. The clearest answer concerns phase 2: the shift from a builder-specified baseline to pathway personalisation and interface simplification coincided with the sharpest engagement redistribution recorded in the study, and phase 3's parallel investment in individual and collaborative tools met a diversification of student needs that had become visible only once earlier barriers were addressed. Mapped onto UDL, these decisions substantially advanced the principles of engagement and, to a lesser extent, representation and action/expression — but did so while leaving disability-specific accessibility largely unaddressed, a gap that iterative, usage-responsive design did not and structurally could not close on its own.

The broader lesson for design teams in comparable contexts is twofold: an iterative, evidence-responsive process can move a platform meaningfully toward UDL's engagement and representation ideals without disability-specific engineering, but it should not be mistaken for having achieved UDL compliance. Genuine inclusion requires treating accessibility as a design objective from the outset, evaluated on its own terms, rather than as a property expected to emerge from responsiveness to the majority of users' behaviour.

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