Digital Technology Use in an Ecuadorian Public School: Insights to Inform a User-Centred Virtual Environment for English Language Teaching

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***Abstract*—In numerous Global South contexts, including Ecuador, wherein English proficiency remains low while schools encounter persistent infrastructural constraints, the promise of digital learning frequently collides with everyday challenges. This mixed-methods study examines how educational technology is experienced in a public secondary school and utilises the resulting insights to inform the design of a user-centred Virtual Learning Environment (VLE) for English Language Teaching (ELT). Data were collected from 155 participants—specifically, 133 students, 18 teachers, and 4 school leaders—using the SELFIE survey, semi-structured interviews, and classroom observations. The findings reveal a pronounced gap between stakeholders' willingness to innovate and the persistent barriers that they face, with technology use remaining largely basic and teacher-centred. Triangulation of the three data sources highlights recurring constraints related to connectivity, device availability, wayfinding, and workload, alongside clear indications of motivation and openness to improving practice. On this basis, we derive design requirements that prioritise low-bandwidth delivery, device-agnostic access, minimal-click navigation, and concise feedback loops suitable for classroom orchestration. These requirements are grounded in converging evidence and presented as actionable guidance for comparable low-resource settings. This study concludes that effective solutions must be genuinely user-centred, supporting the co-design of a VLE for ELT that responds to on-the-ground realities and fosters more equitable learning pathways.**

***Keywords*—digital technology, English Language Teaching (ELT), low-bandwidth design, low-resource schools, stakeholder perspectives, user-centred design, Virtual Learning Environment (VLE)**

I. Introduction

The abrupt migration to online schooling because of the COVID-19 pandemic reminded the world that technology can be both a lifeline and a fault line for education [1]. Although digital devices and bandwidth became as essential as textbooks, this transition also exposed notable gaps in access, training, and institutional support, particularly in the Global South (GS) [2, 3]. In Latin America, structural inequality and insufficient infrastructure continually challenge the promise of Digital Learning (DL), creating a landscape of unfulfilled potential [4].

This academic fragility is particularly acute in Ecuador, where foundational learning deficits are severe; for instance, two of every three sixth graders do not attain basic reading proficiency [5]. These challenges extend to language learning, with the country consistently ranking low on the English as a Foreign Language (EFL) English Proficiency Index [6]. Thus, English Language Teaching (ELT) serves as a telling microcosm of this tension. Although digital tools—such as games, adaptive quizzes, and personalised learning paths—hold the potential to transform learning [7–9], their effectiveness is generally neutralised when teachers are left unprepared and overwhelmed [10, 11].

The dominant approach of merely providing hardware or generic applications usually fails because it disregards the local context. Educators frequently oscillate between enthusiasm and frustration as intermittent internet, limited training, and scarce technical support undermine their instructional efforts [12]. As research has demonstrated, Educational Technology (ET) is effective in low- and middle-income countries only when infrastructure is integrated with robust teacher support, localised content, and strong pedagogy [3]. One promising pathway for addressing this gap is the development of Virtual Learning Environments (VLEs). However, for a VLE to be more than just another piece of ineffective software, it must be carefully co-designed based on a deep understanding of its end-users' needs, challenges, and everyday realities [13]. This highlights a critical need for preliminary, on-the-ground research before any technological solution is developed [14].

This study investigates this intersection of aspiration and limitation by focusing on the Escuela de Educación Básica "San Felipe Neri" (SFNS), a public institution in Riobamba, Ecuador. The SFNS is not an emblematic or high-performing school; instead, it represents the everyday reality of numerous semi-urban and rural institutions across Latin America, where limited infrastructure, unreliable internet, and overburdened teachers are the norm [15]. Its typicality makes it a highly relevant case for exploring how ET is experienced and for generating the insights required to inform context-sensitive design.

Therefore, this exploratory empirical study adopts a mixed-methods approach to develop a holistic understanding of how ET is utilised and perceived by key stakeholders—namely, students, teachers, and school leaders—within this specific school context. It aims to provide the empirical foundation necessary for the future co-design of a user-centred VLE. Specifically, this study represents the preliminary "analysis and exploration" phase of a broader Design-Based Research (DBR) trajectory [16, 17]. By first establishing a robust diagnosis of the school context, we seek to avoid the common pitfall of deploying generic solutions that prove unsustainable in low-resource ecosystems.

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A review of current studies indicates that the literature identifies the key components of successful ET integration, stakeholder roles, and VLE design. However, these elements are typically examined in isolation. A significant gap remains in research that provides "ground-truth" evidence of how infrastructural, human, and pedagogical factors interact and are collectively experienced in a single, typical, low-resource school. This study addresses this gap by foregrounding stakeholder perspectives to generate holistic, contextualised evidence, which has been neglected by national programmes yet is essential for developing scalable and effective edtech strategies [18, 19].

This study is guided by the following Research Questions (RQs):

RQ1: How do stakeholders experience ET use in this specific school context?

RQ2: What insights can be drawn from these perspectives to inform the co-design of a user-centred VLE that effectively addresses the needs of ELT in similar contexts?

II. Literature Review

The main concepts underpinning the study are explained below. This review first establishes the complex nature of ET integration, then examines the interconnected roles and perceptions of its key stakeholders and concludes by discussing research on VLEs for ELT. This synthesis reveals a critical gap in the literature that this study aims to address.

A. ET Integration in Schools: A Multidimensional Process

Notably, ET refers to the systematic utilisation of digital resources to enhance learning [20]. However, its integration reflects a deeper concept, defined as the process of embedding technology into the curriculum and instruction as a seamless and essential component, rather than a mere add-on [21]. Across the GS, achieving this integration level is challenging, as implementation conditions differ markedly from high-income settings and depend on a complex interplay of infrastructure, teacher preparation, and organisational culture [3].

Evidence from Latin America, Sub-Saharan Africa, and South Asia suggests that unreliable connectivity, limited device-to-pupil ratios, and sporadic technical support impede ET use in classrooms [15, 18, 22–24]. Beyond hardware, success depends on human factors. Teachers generally lack the sustained Professional Development (PD) required for more than superficial adoption [25], rendering supportive school leadership essential. School heads who prioritise innovation and continuous training foster stronger digital cultures, while broad community engagement is critical for ensuring local relevance and overcoming resistance [26, 27].

B. Stakeholders' Roles and Perceptions in the ET Ecosystem

A stakeholder-centred perspective is pivotal for understanding ET integration. Teachers occupy a central role, as their Digital Competences (DCs), pedagogical orientations, and ethical awareness of issues such as data privacy directly influence how technology is utilised [28, 29]. Their confidence is usually associated with their teaching style, with student-centred teachers reporting higher uptake than those employing more transmissive methods [30]. Likewise, students are not passive recipients; rather, their exposure, motivation, and digital skills mediate learning outcomes [31]. In turn, school leaders enable the entire ecosystem, with their commitment to investing in both infrastructure and training strongly predicting the institution's overall digital maturity [32].

C. Effective VLE Design for ELT

A VLE is a web-based platform providing tools to support and manage online learning, including content delivery, assessment, and communication [33]. For ELT, VLE effectiveness is realised when pedagogy and accessibility are aligned [34]. Within the specific field of computer-assisted language learning, scholars emphasise that VLE design must extend beyond mere content delivery. Research has indicated that for language acquisition to occur in digital spaces, the environment must explicitly support interaction and the "negotiation of meaning" between learners, rather than merely digitising traditional drill-and-practice exercises [34, 35].

Key pedagogical principles derived from communicative language teaching and task-based activities are paramount [36]. These principles are enabled by technological features that enhance motivation, including gamification—defined as "the use of game-like elements in non-game contexts" [37]—and personalised pathways [38, 39].

Critically, in numerous GS contexts, VLEs must be designed for inclusivity by applying principles of Universal Design for Learning [40], a framework aimed at fostering flexible learning environments that accommodate individual differences, and by ensuring that they operate on low bandwidth and across varied devices [19].

Furthermore, recent analyses have emphasised that generative Artificial Intelligence (AI) is beginning to influence how VLEs support personalisation, feedback, and resource generation. International reports have suggested that AI tools may complement VLE functionality by providing adaptive guidance and multimodal language input, even though their adoption must remain aligned with local infrastructure, ethical safeguards, and teacher readiness [41, 42]. Additionally, empirical studies published in 2024 have demonstrated that AI-enhanced platforms strengthen feedback loops and differentiation when embedded within well-designed VLEs [43, 44]. However, global surveys have warned that unequal access to devices, limited connectivity, and gaps in digital competence continue to restrict AI's pedagogical impact in several schools [45]. Although AI is not this study's primary focus, these developments underscore the need for VLE designs grounded in real school conditions, as documented herein, to provide a baseline for any future, carefully governed integration of generative-AI features in this context.

III. Materials and Methods

A. Research Design

From a methodological viewpoint, this study represents the "context analysis" phase within a broader DBR framework. Before entering the iterative cycles of design and testing, DBR necessitates a thorough understanding of the problem in its natural setting. Consequently, this study employed an explanatory sequential mixed-methods design to gain a comprehensive understanding of the topic [46]. A quantitative phase was conducted first to identify general patterns of technology use and address the "what" of RQ1. Subsequently, a qualitative phase involved analysing the "why" underlying these initial patterns and gathering contextual insights for informing VLE design (RQ2). A third phase involved observing technology-related practices in everyday instructional settings to complement and refine the preceding findings. Integration occurred through side-by-side comparison of quantitative trends and qualitative explanations, supported by joint displays that highlighted convergences and divergences across phases. This sequential approach was selected because it allows initial quantitative tendencies to be interpreted and contextualised through in-depth qualitative exploration, which is particularly important in low-resource school settings. This study is deliberately limited to a contextual diagnosis, serving to precede and inform subsequent DBR and co-design iterations.

B. Participants and Context

This study was conducted at the SFNS, a public institution in a semi-urban area of Riobamba, Ecuador, offering both primary and secondary education. The school serves a student population predominantly from low-income families, with a significant representation of Indigenous and migrant backgrounds, rendering it a relevant example of an under-resourced context. Participants were selected through purposive sampling to include all key stakeholder groups. The sample (n = 155) comprised 133 students (ages 12–15), 18 teachers (13 women and 5 men) from different subject areas, and four school leaders from the first three years of secondary education. Among the teachers, eight participants volunteered to participate in the follow-up interviews, reflecting a range of teaching experience and digital familiarity levels.

The student group was approximately gender-balanced (56% women and 44% men). The teaching staff had professional experience ranging from 5 to 25 years, ensuring perspectives from both novice and veteran educators.

C. Data Collection Instruments

Quantitative data were collected using SELFIE (i.e., Self-reflection on Effective Learning by Fostering the use of Innovative Educational Technologies), an institutional self-reflection tool developed by the European Commission for use by students, teachers, and school leaders. The instrument provides a structured snapshot of the perceived availability, use, and integration of Digital Technologies (DTs), as well as users' attitudes. Further, SELFIE employs a five-point Likert scale (1 = lowest; 5 = highest) and examines the following eight domains: (A) Leadership, (B) Collaboration and Networking, (C) Infrastructure and Equipment, (D) Continuing Professional Development, (E) Pedagogy: Support and Resources, (F) Pedagogy: Implementation in the Classroom, (G) Assessment Practices, and (H) Student Digital Competence [47]. Responses are aggregated by participant role (students, teachers, school leaders) and are not disaggregated by demographic variables, such as grade level or age.

Consistent with its intended purpose, SELFIE is designed to support institutional reflection, dialogue, and improvement planning by identifying strengths, weaknesses, and divergences across stakeholder perceptions; its Likert-scale indicators are intended for internal diagnosis and school-level benchmarking. Accordingly, the aggregated scores reported herein are interpreted as descriptive perceptions of DT use and conditions. Therefore, comparisons across stakeholder groups (leaders, teachers, students) should be performed cautiously, as items are framed differently for each group and responses may be influenced by self-report bias, social desirability, and contextual interpretation.

Additionally, to gather rich, in-depth qualitative data, semi-structured interviews (≈ 40 min) were conducted with eight volunteer teachers. The interview protocol utilised open-ended questions to elicit detailed narratives regarding their daily experiences, challenges, and successes with ET. Further, it proceeded to specific probes on pedagogical strategies, such as gamification and personalised learning, concluding with questions about their ideal features for a VLE. Table 1 presents a summary of the guiding questions, translated from the original Spanish protocol. These interviews were central to collecting the direct, user-centred data necessary to inform RQ2.

Table 1. Summary of the semi-structured interview protocol for teachers (translated from Spanish)

Dimension of Inquiry	Key Interview Questions
Student Motivation & Learning	• What changes have you observed in student motivation when learning with technological tools? • From your experience, how does technology use influence learning retention? • Do you consider that students learn more effectively with technology support compared to conventional methods?
Teaching Practice & Challenges	• What have been the main challenges that you have faced when integrating technology into your teaching practice? • How has your experience been teaching with digital tools compared to traditional methods? • In terms of time and effort, how has your work changed with the incorporation of technology?
Virtual Learning Environment (VLE) Design & Strategies	• Have you employed any strategies to adapt your teaching to individual students' needs through technology? • Have you utilised gamification or personalisation strategies in your classes? • What features do you consider essential in a VLE to improve English teaching?

Finally, non-participant classroom observations were conducted to provide direct evidence of practice, guided by the Technology Integration Matrix (TIM) [48]. A total of eight lessons were observed. Although this sample size was limited, the sessions were purposively selected to represent typical instructional hours across the participating grades. A consistent pattern of technology use emerged across these sessions, suggesting data saturation [49], as the observed pedagogical limitations were repetitive and aligned with the survey findings. Therefore, additional observations were considered unlikely to yield divergent structural insights. These observations primarily served to triangulate and validate the self-reported trends identified in the broader SELFIE survey, rather than functioning as the sole indicator of pedagogical culture.

D. Data Analysis

The analysis commenced with the quantitative data from the automated report generated by the SELFIE tool, which provided aggregated descriptive statistics (i.e., means, ratings, and frequencies). These results were compared across the three participant groups to identify initial trends and divergences. To build on these findings, qualitative data from interview transcripts were analysed thematically using ATLAS.ti. This process involved an inductive approach [50] of open coding text segments, grouping codes into six interpretive categories, and, finally, employing the co-occurrence analysis tool to map relationships between codes. To illustrate this analytical trajectory, raw data segments mentioning specific issues (e.g., “Internet is slow”, “projector doesn’t connect”) were first assigned descriptive open codes (e.g., “connectivity failure”, “hardware incompatibility”). Thereafter, these were collated into broader categories (e.g., “technical barriers”), which were iteratively refined and cross-referenced with positive distinctors to form the final aggregate theme, “Difficulties in using technology”. This process involved constant comparison to ensure distinctness between themes.

In parallel, classroom observation data were analysed using a deductive approach based on the TIM descriptors. Instead of simply assigning a global label to a lesson, the observer recorded specific teacher and student behaviours in field notes and mapped these specific instances against the TIM rubric criteria for the “Entry”, “Adoption”, or “Adaptation” levels. This procedural mapping ensured that the classification of technology integration was detailed and evidence-based, not merely impressionistic.

The analytical process culminated in the triangulation of these data streams for cross-verification. Specifically, the rich qualitative themes and structured observation data were employed to explain and contextualise the broader quantitative trends.

A rigorous protocol was followed to ensure the credibility and dependability of the qualitative analysis. All interviews were conducted in Spanish to facilitate rich expression and were transcribed verbatim. The illustrative excerpts were translated into English by the first author and subsequently cross-checked by a bilingual peer to preserve contextual nuance and accuracy. The thematic analysis employed an iterative coding process: Initial open codes were generated, then grouped into interpretive categories, and, finally, refined into themes through peer debriefing sessions with the second author. This process of “investigator triangulation” helped minimise interpretative bias and ensured that the identified themes accurately reflected the teachers’ voiced experiences.

E. Ethical Considerations

This study was conducted under the academic supervision of the Doctoral School at the University of the Balearic Islands. Considering this study’s diagnostic and non-interventional nature, formal review by an institutional Ethics Committee was not required. However, this study adhered strictly to the ethical guidelines of the British Educational Research Association [51] to ensure the protection of all participants. Authorisation to access the site and collect data was formally granted by the school leadership. Written informed consent was obtained from all teachers and student participants’ parents or legal guardians. Additionally, explicit digital assent was secured from students before they participated in the SELFIE survey, while all data were anonymised to maintain confidentiality.

IV. Result and Discussion

This section presents the core findings obtained from the various instruments employed herein. The results are organised according to data source and type.

A. DTs in the School Context: SELFIE Results

The analysis commenced with an overview of the data collected using the SELFIE tool. The data collection process achieved a high response rate, resulting in a final sample of 155 participants from the SFNS school community. Table 2 presents the distribution of study participants by role.

Table 2. Distribution of study participants by role

Participant Group		Frequency (*n*)	Percentage (%)
Lower Secondary (8th, 9th, and 10th Grade)	Students	133	85.80%
	Teachers	18	11.60%
School Leaders		4	2.60%
Total		155	100%

As illustrated in Fig. 1, participation rates were high across all groups, with 100% of school leaders (4), 100% of teachers (18), and 96% of students (133 of 138) completing the questionnaire. Some SELFIE items are presented only to specific respondent groups (e.g., Leadership questions are answered exclusively by school leaders and teachers); hence, any blank cells in the following figures for a group indicate items that were not presented to them.

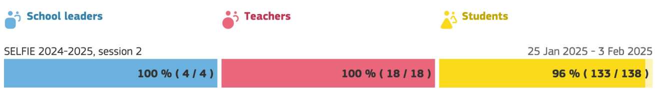

Fig. 1. Completion rates by group in the SELFIE self-reflection exercise.

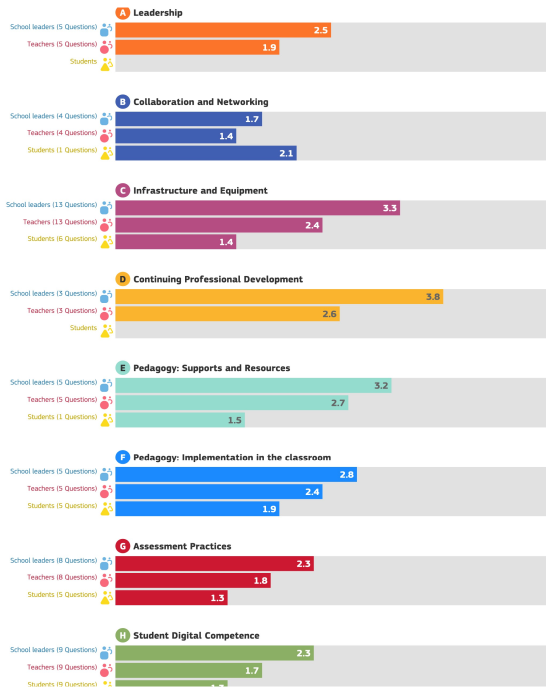

Fig. 2. Overview of responses by area and user group.

Fig. 2 presents the descriptive statistics for the eight

SELFIE domains by participant group, providing a visual summary of mean scores for school leaders, teachers, and students across all categories. The analysis focuses on the main responses of these domains. Notable differences in perceptions emerged among the three groups. School leaders reported the highest ratings in Infrastructure and Equipment (3.3) and Continuing PD (3.8). By contrast, students exhibited the lowest scores, with averages below 2.0 in nearly all categories, particularly in Assessment Practices (1.3) and Pedagogy: Support and Resources (1.5). Teachers' responses were intermediate, reflecting moderate perceptions of support and use of DTs, especially in Pedagogy: Implementation in the Classroom (2.4) and Continuing PD (2.6).

Following the presentation of general trends, the following sections focus on four selected areas from the SELFIE domains, as they are deemed most relevant to this study.

1) Leadership

Fig. 3 reveals that the items "Digital strategy" and "Strategy development with teachers" received the lowest ratings across all three groups, with school leaders scoring both at 1.0 and teachers slightly higher at 1.1 and 1.2, respectively. "New ways of teaching" received moderate ratings (2.5 leaders, 1.8 for teachers, 2.1 average), while "Time to explore digital teaching" was rated the highest (4.5 for leaders, 3.3 for teachers, 3.9 overall), suggesting that this is the most supported aspect within this area.

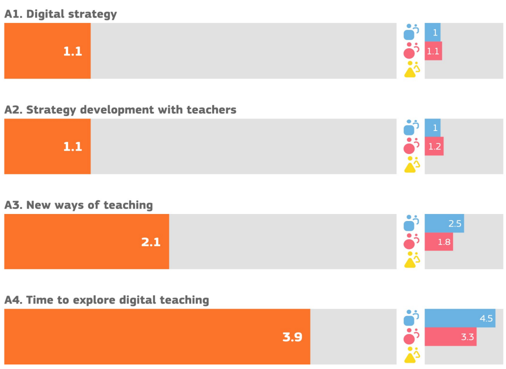

Fig. 3. Scores for leadership.

2) Infrastructure and equipment

Fig. 4 reveals marked differences between school leaders, teachers, and students. School leaders rated "Internet access" (4.8), "Digital devices for teaching" (4.3), and "Physical spaces" (3.8) as highly available, whereas students assigned substantially lower scores for "Internet access" (1.4) and "Digital devices for teaching" (1.4), indicating notable disparities in access. Technical support received more modest ratings across all groups (3.3 by leaders, 2.4 by teachers, 1.3 by students). Data protection was rated the lowest (1.0) by both leaders and teachers.

3) Pedagogy: Implementation in the classroom

Fig. 5 reveals that "Engaging students" received the highest score (3.0 overall; 3.5 from students), indicating that DTs enhance learner motivation. Conversely, "Student collaboration" received the lowest rating (1.9 overall; 1.3 from students), suggesting limited opportunities for peer interaction through digital means. Likewise, students rated "Fostering creativity" and "Tailoring to students' needs" relatively low (1.3 and 1.5), suggesting challenges in using technology to personalise learning and support creative expression.

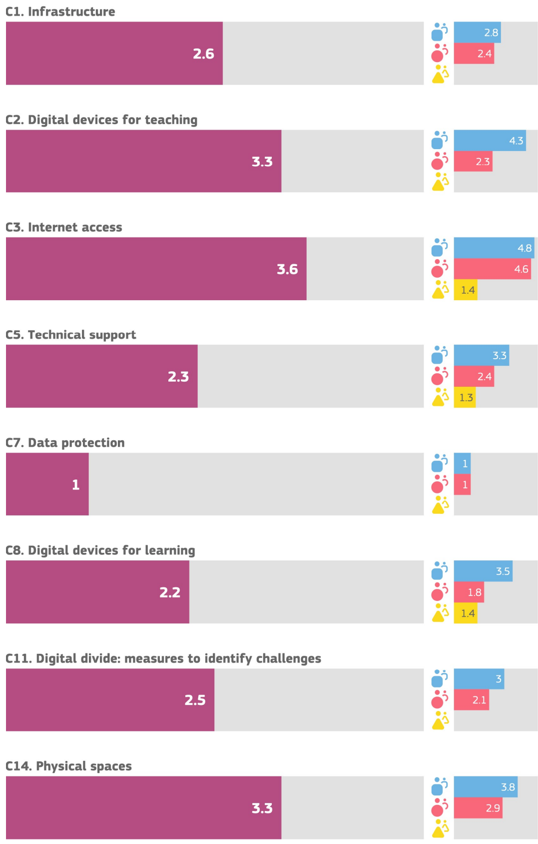

Fig. 4. Scores for infrastructure and equipment.

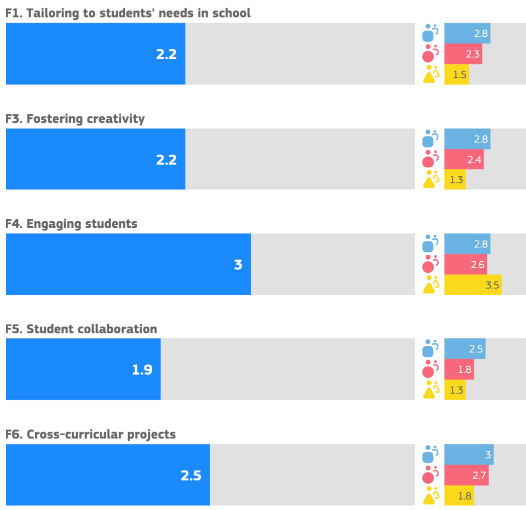

Fig. 5. Scores for pedagogy: Implementation in the classroom.

4) Student DCs

Fig. 6 reveals that "Creating digital content" (1.4) and "Giving credit to others' work" (1.5) received the lowest scores, highlighting significant gaps in students' production and ethical use of digital information. Slightly higher ratings were reported for "Digital skills across subjects" (2.1) and "Learning to communicate" (2.0), with school leaders assigning relatively higher scores (up to 3.0) than students and teachers.

In addition to these key areas, SELFIE generated complementary data. The following selected aspects help contextualise the main results by emphasising user confidence, access conditions, and perceived barriers to the use of DTs.

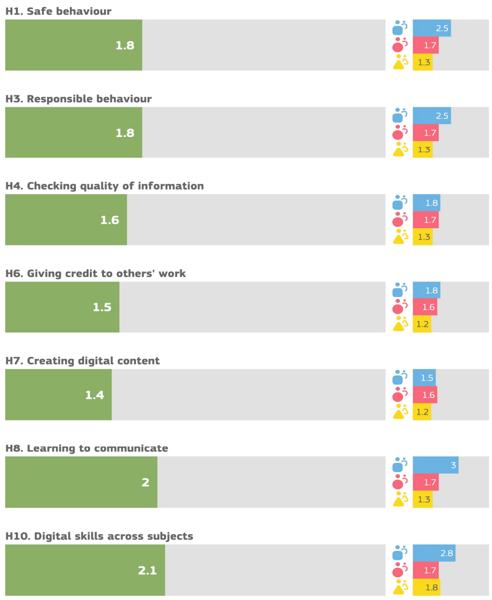

Fig. 6. Scores for student digital competences.

5) *Factors inhibiting technology use*

Fig. 7 reveals several key barriers impeding the effective use of DTs, as identified by school leaders and teachers. The most frequently cited challenges were "Lack of funding" (100% of leaders, 77% of teachers), "Insufficient digital equipment" (75% and 88%, respectively), and "Limited or no technical support" (100% and 61%). Further, both groups highlighted "Low digital competence of students" (75% and 72%) and "Low digital competence of teachers" (100% and 72%) as critical obstacles. Additional concerns included "Lack of time for teachers" (25% of leaders, 55% of teachers) and, to a lesser extent, "School space restrictions".

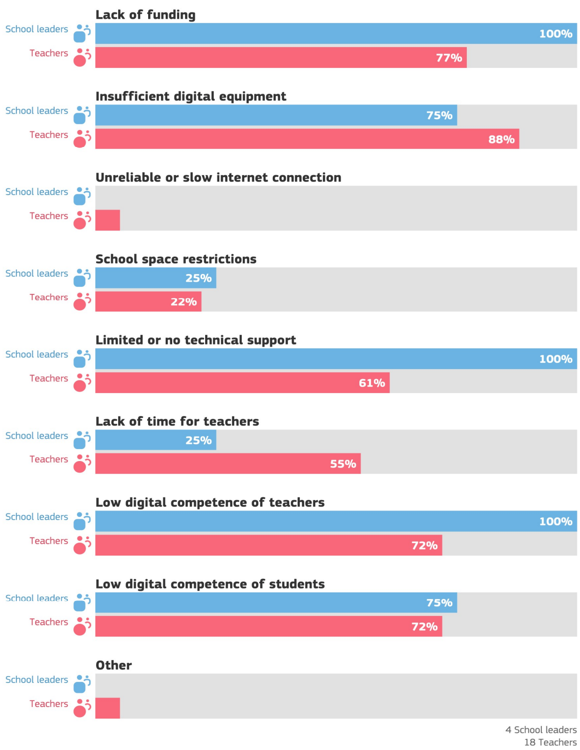

Fig. 7. Perceived barriers to the use of DTs in school.

6) *Confidence in using technology*

Fig. 8 reveals that teachers reported varying levels of confidence when using DTs for different teaching tasks. Confidence was highest for "Communication" (3.9), with 72% of teachers rating themselves as "confident" or "very confident". By contrast, confidence was lower for tasks such as "Feedback and support" (2.4) and "Class teaching" (2.7), with most responses ranging from "a little bit confident" to "confident". "Preparing lessons" received a moderate score of 2.9.

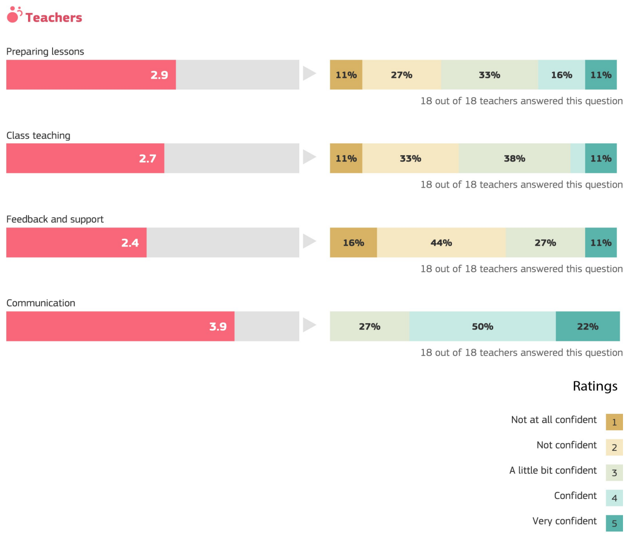

Fig. 8. Teachers' confidence in using DTs for teaching-related tasks.

7) *Technology adoption*

Fig. 9 reveals that school leaders reported a slightly higher level of technology use (2.8) than teachers (2.4). Among leaders, 75% identified as early adopters or innovators (ratings of 3 or 4), whereas teachers exhibited a more moderate adoption pattern, 44% using DTs at the same pace as colleagues and only 5% considering themselves innovators.

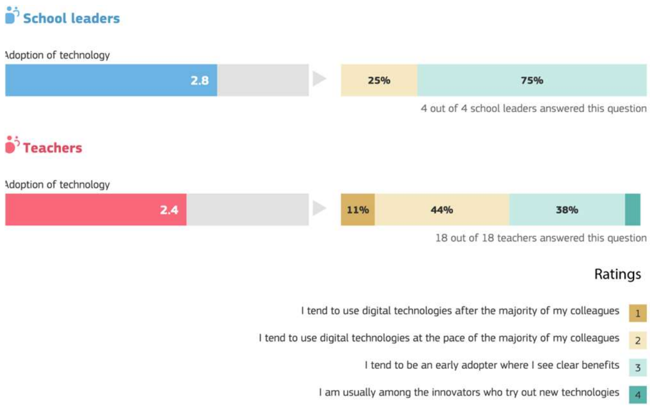

Fig. 9. Perceptions of technology adoption.

8) *Student access to devices outside school*

Fig. 10 reveals that students reported relatively positive access to digital devices at home, with a mean score of 3.8. Overall, 38% have a suitable personal device for schoolwork, while 24% have a shared device that is available when needed. Another 20% rely on a shared device that is not always available, while 15% have no suitable device at all.

Thus, 35% of students still have limited or no access.

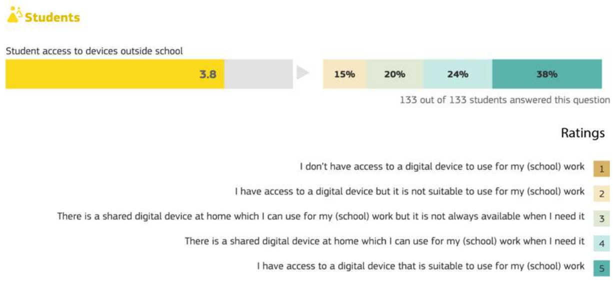

Fig. 10. Students' access to digital devices outside school.

B. Teachers' Perceptions of ET: Interview Findings

The qualitative data from the eight teacher interviews were thematically analysed to understand their perceptions of ET. The analysis yielded the following six principal themes that reflect the teachers' experiences: (1) "Access and technological availability", (2) "Difficulties in using technology", (3) "Technological strategies and tools in teaching", (4) "Technology's impact on learning", (5) "Need for technology training", and (6) "Teachers' perceptions of technology". These themes' frequency and the relationships between them are detailed below.

An analysis of theme co-occurrence revealed how certain concepts were interconnected in the teachers' accounts (Table 3). Notably, "Difficulties in using technology" most frequently co-occurred with "Access and technological availability", suggesting that teachers do not perceive daily operational challenges as isolated incidents but as direct consequences of unstable Internet and poor equipment—a point repeatedly emphasised in the interviews.

Table 3. Co-occurrence matrix of codes in teacher interviews

Coded Categories	**Access and technological availability (Gr = 11)**		**Difficulties in using technology (Gr = 32)**		**Technological strategies and tools in teaching (Gr = 32)**		**Technology's impact on learning (Gr = 33)**		**Need for technology training (Gr = 23)**		**Teachers' perceptions of technology (Gr = 44)**	
	Count	**Coefficient**	**Count**	**Coefficient**	**Count**	**Coefficient**	**Count**	**Coefficient**	**Count**	**Coefficient**	**Count**	**Coefficient**
Access and technological availability (Gr = 11)	0	0.00	5	0.13	0	0.00	0	0.00	0	0.00	0	0.00
Difficulties in using technology (Gr = 32)	5	0.13	0	0.00	0	0.00	1	0.02	4	0.08	0	0.00
Technological strategies and tools in teaching (Gr = 32)	0	0.00	0	0.00	0	0.00	5	0.08	0	0.00	1	0.01
Technology's impact on learning (Gr = 33)	0	0.00	1	0.02	5	0.08	0	0.00	0	0.00	3	0.04
Need for technology training (Gr = 23)	0	0.00	4	0.08	0	0.00	0	0.00	0	0.00	1	0.02
Teachers' perceptions of technology (Gr = 44)	0	0.00	0	0.00	1	0.01	3	0.04	1	0.02	0	0.00

Note: Gr = groundedness (total quotations associated with each code across all interviews); Count = number of co-occurrences between the row and column codes; Coefficient = normalised co-occurrence index (0–1). Diagonal cells are zero or omitted.

To understand each theme's prominence, a frequency analysis was conducted across all interviews (Table 4). "Teachers' perceptions of technology" was the most frequently cited theme (44 instances), indicating its central role in the discussions. This was followed by "Technology's impact on learning" (33 instances) and "Difficulties in using technology" (32 instances), both of which appeared in nearly every interview, highlighting them as shared, core experiences. Other themes, such as "Technological strategies and tools" (32 instances) and "Need for technology training" (23 instances), exhibited greater variation, reflecting the different levels of detail provided by each teacher.

Table 4. Frequency of coded categories in teacher interviews

Coded Categories (with Group Size Gr)	**Interview 1 (Gr = 21)**	**Interview 2 (Gr = 22)**	**Interview 3 (Gr = 13)**	**Interview 4 (Gr = 22)**	**Interview 5 (Gr = 21)**	**Interview 6 (Gr = 17)**	**Interview 7 (Gr = 17)**	**Interview 8 (Gr = 22)**	**Total**
Access and technological availability (Gr = 11)	2	2	1	1	0	2	1	2	11
Difficulties in using technology (Gr = 32)	2	3	3	4	5	5	6	4	32
Technological strategies and tools in teaching (Gr = 32)	2	8	2	5	2	1	5	7	32
Technology's impact on learning (Gr = 33)	9	5	4	5	3	1	2	4	33
Need for technology training (Gr = 23)	5	3	0	3	7	1	1	3	23
Teachers' perceptions of technology (Gr = 44)	3	2	5	5	7	10	5	7	44
Total	23	23	15	23	24	20	20	27	175

Note: Gr (columns) = total coded segments per interview; Gr (code labels) = groundedness (total quotations for that code across all interviews). Cells present per-interview counts; rightmost Total = code Gr; bottom Total = interview sum. Column totals may exceed interview Gr values because single segments were assigned multiple codes simultaneously.

Teachers are eager to experiment with digital tools; however, unreliable internet, ageing devices, and limited leadership support leave them working in isolation, teaching themselves new platforms and replicating SELFIE's low scores for collaboration. To explore these patterns in greater depth, the following account integrates teachers' voices throughout the analysis. Their remarks indicate that everyday technological frustrations stem directly from the school's limited resources, leaving them torn between a desire to innovate and a fear of falling short. As one teacher admitted, "A veces digo voy a hacer algo chévere, pero el tiempo no me alcanza y termino explicando en el pizarrón" (T8: "Sometimes I plan something exciting, but time slips away, and I end up teaching on the whiteboard"). Another positioned the issue as a matter of social justice: "¿Qué pasa si el estudiante no tiene acceso a internet o un celular en su casa? Entonces se vuelve un problema de equidad" (T6: "What happens if a student has no internet or phone at home? Then it becomes an equity problem").

These daily challenges shape a nuanced view of technology, wherein its worth is judged solely by what it contributes to learning. As one teacher explained, "Si la tecnología los hace pensar, muy bien, pero si solo los acostumbra solo a apretar botones, está mal" (T6: "If technology makes them think, great, but if it only makes them accustomed to pressing buttons, it is wrong"). This pragmatic stance is generally accompanied by a call for improved training: "Los profes también necesitamos apoyo para aprender a usarla bien, porque si no, terminamos improvisando y eso tampoco es bueno" (T8: "Teachers also need support to learn to use it properly; otherwise, we end up improvising, and that is not good either").

As Fig. 11 illustrates, scarce access and minimal training contribute to everyday technical difficulties, which, in turn, shape teachers' attitudes and practice. When deliberate, school-wide strategies are implemented, this cycle can be disrupted, highlighting that meaningful technology-enhanced learning depends on systemic support rather than individual perseverance.

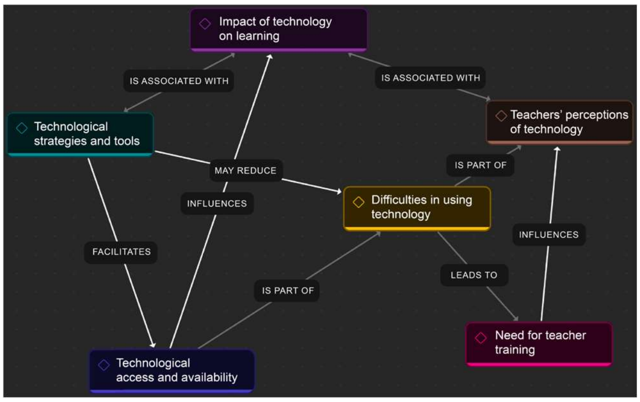

Fig. 11. Thematic map based on interview analysis.

C. Classroom Technology Use: TIM Observation Findings

Direct classroom observations provided a clear overview of how technology is employed in practice, largely corroborating the themes from the interviews and quantitative SELFIE data. A consistent pattern of teacher-centred technology use emerged across the eight observed lessons, with limited opportunities for authentic student interaction or knowledge construction.

In most lessons (six out of eight), technology use remained at the TIM framework's Entry level, typically involving teachers using a projector for PowerPoint slides or showing short videos, whereas students remained largely passive recipients of information. In only two lessons, the practice advanced to the Adoption level. In these cases, learners—under close supervision—utilised a shared website to complete scaffolded tasks in pairs. However, even here, the teacher strictly dictated the sequence, tools, and outcomes, thus reinforcing a traditional pedagogical model. Fig. 12 visually summarises the pronounced skew towards these basic integration levels.

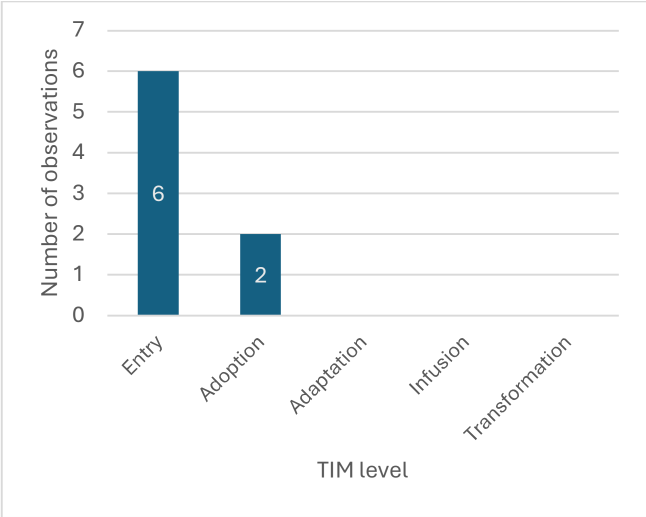

Fig. 12. Levels of technology integration observed (Technology Integration Matrix (TIM) framework).

D. Discussion

We interpret the findings in relation to the RQs, integrating evidence from the results with previous studies, theoretical frameworks, and the broader educational context. Following this analysis, the study's limitations and directions for future research are presented; finally, the study's implications are delineated.

1) RQ1: How do stakeholders experience ET use in this specific school context?

Stakeholders at the SFNS have access to ET in a discontinuous and unequal manner. This is evident in the SELFIE results, wherein Infrastructure and Equipment averaged 3.3, 2.4, and only 1.4 for school leaders, teachers, and students, respectively. Although teachers indicated an interest in applying DTs, their capacity for effective implementation is limited owing to a lack of hardware, training, and institutional support. Similar challenges have been widely documented in global contexts. For example, Dolo and Flomo [52] reported that Liberian teachers are restricted by poor infrastructure and insufficient training, despite exhibiting a strong willingness to integrate technology. Likewise, Francom [53] found that although device access in U.S. classrooms improved over time, the steady decline of technical support and training limited effective use.

Similarly, Lucas [54] examined a one-to-one tablet initiative in Portugal and identified infrastructure gaps, scheduling restrictions, and a lack of adequate training as persistent obstacles. These structural issues place the burden of digital inclusion onto individual teachers. The literature has demonstrated that such decentralised responsibility models are widespread and problematic. For instance, Joshi and Khatiwada [55] stated that in low-resource educational settings, educators contend with inadequate infrastructure, insufficient policy alignment, and time constraints. At the SFNS, 55% of teachers reported a lack of time for digital work and rated feedback and support with DTs at only 2.4, while classroom observations revealed that six of eight lessons remained at the Entry level of technology integration.

This predominance of Entry-level use can be interpreted through established pedagogical frameworks. According to the Substitution, Augmentation, Modification, Redefinition (SAMR) model [56], practices wherein technology primarily substitutes traditional tools—such as replacing a blackboard with a projector—represent Substitution, offering no functional enhancement to the pedagogy. Furthermore, from the perspective of the Technological Pedagogical Content Knowledge (TPACK) framework [57], this pattern suggests that the core challenge extends beyond a lack of technical skill (i.e., technological knowledge) to the difficulty in developing the integrated knowledge for effectively combining technology with pedagogy and content (i.e., TPACK).

Beyond the functional classifications of SAMR and TPACK, these findings align closely with appropriation theory in low-resource contexts. As researchers in the GS have argued, teachers do not merely "adopt" or "fail to adopt" technology; rather, they appropriate it to accommodate their material constraints [3, 58]. The prevalence of Entry-level use observed at the SFNS—where powerful tools are employed merely for projection—should be understood not as a lack of skill but as a pragmatic adaptation to the scarcity of student devices and reliable internet. In this manner, teachers are effectively negotiating a form of structural "digital inequality" [55], wherein official policy demands innovation, yet the local infrastructure generally permits only substitution.

The student perspective, captured quantitatively, presents a parallel view of this teacher-centred reality. Critically low scores for infrastructure (1.4) and self-reported DC (averaging 1.8) suggest that they experience technology primarily as passive recipients rather than active creators. This finding aligns closely with the observed Entry-level classroom practices, reinforcing the conclusion that current ET use at the SFNS does not adequately foster student agency.

This reality becomes even more evident when contrasted with institutional and national policy frameworks. In Ecuador, the national curriculum and two ministerial agreements advocate the use of DTs to foster more meaningful learning [59–61]. However, SFNS practices reveal a persistent disconnect between these official policies and classroom realities. Jothi and Ponrani [62] emphasised that this policy–practice gap is widespread; although technology is promoted at the policy level, its classroom use remains superficial, centred on content delivery rather than pedagogical transformation. Likewise, while the school's institutional curriculum planning reflects intentions to integrate ET and multimodal strategies [63], these statements remain largely aspirational rather than actionable.

Substantiating this view, Christopoulos and Sprangers [64] reported that without institutional alignment and leadership, technology is deployed without long-term planning or pedagogical integration. This highlights the central argument from the literature review that true ET integration is not merely a matter of providing equipment but a complex cultural and pedagogical process. As Cabasan [65] argues, closing the digital divide warrants coherent institutional leadership, inclusive support systems, and ongoing PD structures to enable genuinely transformative learning environments.

2) RQ2: What insights can be drawn from these perspectives to inform the co-design of a user-centred VLE that effectively addresses the needs of ELT in similar contexts?

To address the educational context's complexity and ensure that the design requirements are empirically grounded, Table 5 presents a joint display. This matrix triangulates the broad trends identified in the SELFIE survey with explanatory insights from the teacher interviews and ground-truth evidence from the classroom observations.

Table 5. Joint display: Triangulation of findings and design requirements

Domain of Analysis	Quantitative Findings	Qualitative Evidence	Convergence & Interpretation	Virtual Learning Environment (VLE) Design Requirement
Infrastructure & Equity	Divergence in Perception: School leaders rated Internet Access highly (4.8), whereas students and teachers rated it critically low (1.4) and low (2.4), respectively.	Teacher Interview: "What happens if a student has no internet... Then it becomes an equity problem" (T6). Observation: Reliance on projectors owing to a lack of individual devices.	Divergence → Reality Check: While leaders perceive adequate infrastructure, the qualitative data validate the students' low scores. The reality is one of scarcity.	Device-Agnostic & Low-Bandwidth: The VLE must function offline or with low-data settings to bridge the gap identified by students and teachers.
Pedagogical Integration	Low Collaboration: Student Collaboration received the lowest pedagogy score (1.3). Engaging Students scored higher (3.5), suggesting interest but no interaction.	Teacher Interview: "Time slips away, and I end up teaching on the whiteboard" (T8). Observation: 6 of 8 lessons were at Entry level (TIM Matrix), characterised by passive viewing of slides/videos.	Convergence: Both datasets confirm a teacher-centred model. High student motivation (SELFIE) is bottlenecked by transmissive teaching methods observed in class.	Pedagogical Scaffolding: The VLE must include ready-to-use activity templates and teacher guidance to facilitate the transition from Entry to Adoption levels.
Digital Competence & Autonomy	Passive Consumption: Creating Digital Content received a very low score (1.4). Students reported having devices at home (3.8) but a lack of school-based skills.	Teacher Interview: "If technology... only makes them accustomed to pressing buttons, it is wrong" (T6). Observation: Tasks were strictly dictated by the teacher, with no room for student choice.	Convergence: Students are digital consumers, not creators. The gap does not merely concern access, but the opportunity to use tools autonomously.	Personalised Pathways: To foster agency, the VLE must allow students to select content types and progress at their own pace, moving beyond "button pressing".

This study's findings provide clear design requirements for a user-centred VLE. A noteworthy insight concerns the foundational principle of equity through accessibility. Among the students, 35% still had limited or no access to a suitable device, while another 24% depended on a shared one. Most rely on inadequate or shared devices, limiting equitable engagement with DL. Therefore, a VLE in this setting should be responsive, low-bandwidth, and user-friendly. This is especially critical in ELT because it ensures all students can access core learning materials, such as vocabulary lists and grammar exercises, even if streaming audio for listening practice is not consistently feasible. Li and Wang [35] reported that adaptive platforms enhance engagement in low-resource environments, thus addressing this requirement.

Additionally, personalisation emerges as essential for fostering learner agency. Students rated “Engaging students” at 3.5 but “Tailoring to students’ needs” at only 1.5, indicating that motivation arises when activities are deemed appealing, but adjustment to individual pace is limited. Teachers reported that restricted class time forces them into generic tasks. Therefore, to shift from a teacher-centred model to a more learner-centred one, a user-centred VLE should allow learners to progress at their own pace, select content types (e.g., focusing on grammar exercises or vocabulary-building games), and engage in scaffolded communicative tasks that build real-world language skills. Findings from Villaflor and Zhang [66] and Duong and Seepho [67] on personalised projects align with this need; meanwhile, Zhang and Hasim [68] demonstrated that gamification enhances participation, for instance, by turning vocabulary acquisition into a quest, complementing the surface-level engagement observed at the SFNS.

Moreover, the VLE must provide embedded pedagogical support for teachers. Teachers reported low confidence in providing feedback and limited access to PD (2.4 and 2.6, respectively). The interview theme “Need for teacher training” appeared 23 times, further highlighting this gap. Consequently, a VLE must act as pedagogical scaffolding for teachers, directly embedding guidance through templates for ELT lesson plans, activity banks with level-appropriate reading materials, and concise methodological tips for facilitating online speaking practice, rather than relying solely on occasional workshops.

Furthermore, the data underscore the value of co-design. Both teachers and students expressed motivation to improve digital practice, with “Engaging students” averaging 3.0 when activities encouraged active participation. Involving users in iterative testing of layouts and tasks—such as a new dialogue-building module or a collaborative writing tool—would ensure that the platform evolves with local needs, as de Benito et al. indicated [16].

The design requirements derived from our findings provide a blueprint for a user-centred ELT-oriented VLE, as discussed in the literature. It must combine low-bandwidth accessibility to bridge the digital divide, personalised paths to foster learner agency, and embedded pedagogical support to build teacher capacity. This approach, if thoughtfully applied, can extend beyond surface usability to support equitable, high-quality ET integration in comparable GS contexts. Although these elements align with widely recognised good practice for technology integration in low-resource environments, in this study they are explicitly grounded in the specific access constraints, pedagogical patterns, and stakeholder perceptions documented at the SFNS.

While generative AI is not the focus of this diagnostic study, the findings delineate the conditions that would need to be in place before such tools could be meaningfully considered within a future VLE for this context. Recent work on generative AI in education suggests that its benefits for feedback, differentiation, and resource generation depend on robust infrastructure, clear governance, and sustained teacher capacity-building [43–45]. At the SFNS, the persistent gaps in connectivity, device access, and pedagogical support indicate that any generative-AI functionality should be conceived as a complementary layer to a low-bandwidth, device-agnostic core, rather than as a starting point. In this sense, the study provides a contextual baseline on which any future, carefully governed integration of generative AI into VLE design for low-resource schools in the GS would need to build.

E. Implications

This study’s findings carry direct implications for both practice and policy. For instructional designers and educators, this study offers a concrete blueprint for developing a viable VLE in similar settings. Such a VLE must prioritise low-bandwidth delivery and device-agnostic access to address the significant hardware and connectivity constraints reported by students. Additionally, it must function as pedagogical scaffolding for educators by embedding built-in supports, such as templates and activity banks, directly responding to teachers’ low confidence and expressed need for training. Moreover, personalisation and game-based progression are not optional enhancements but essential design mechanisms for sustaining student motivation in contexts wherein one-size-fits-all approaches have proven inadequate.

For policymakers and the broader research community, this study offers ground-truth evidence that can inform cost-aware, context-sensitive pathways towards Sustainable Development Goal 4, particularly equitable DL. By foregrounding stakeholder perspectives, it highlights that leadership commitment and a collaborative school culture are critical in narrowing the digital divide—consistent with evidence from other low-resource systems, such as Liberia and Nepal.

V. Conclusion

The evidence from SFNS reaffirms a familiar pattern across the GS: A strong willingness to innovate is constrained by everyday realities, including sporadic connectivity, scarce devices, and limited institutional guidance, which narrow what teachers and learners can realistically achieve. The findings demonstrate that when digital tools align with learners’ pace and interests, engagement increases, and when teachers receive just-in-time support, their confidence grows. These results underscore a central conclusion: Technological solutions for such contexts cannot be generic; they must be intentionally designed to be resilient and supportive, accessible on modest hardware and low bandwidth, and capable of scaffolding users’ pedagogical practice.

In contexts wherein the aforementioned infrastructure gaps persist, studies like this one are essential to help uncover relevant systemic barriers while also highlighting the potential within schools—such as stakeholder commitment, local adaptation, and pedagogical insight—that can drive more inclusive and meaningful DL. Following this logic, any exploration of generative-AI enhancements to the school VLE should only be considered once the foundational conditions identified herein (i.e., reliable access, device-agnostic design, and sustained teacher support) are firmly in place.

The generalisability of this study's findings is limited, as a single secondary school cannot represent the diversity of all Ecuadorian or Latin American educational contexts. The SELFIE results were analysed descriptively and without further psychometric validation, so cross-group score differences should be viewed as exploratory patterns in perceived conditions rather than as robust comparative evidence. Additionally, student perspectives were captured only through quantitative data, which offer a broad overview of perceptions but do not reflect the depth of lived experiences; this is a clear limitation for a study that seeks to inform user-centred design.

Further, the qualitative component was limited in scope. Although classroom observations offer consistent snapshots of practice aligned with survey trends, they do not constitute longitudinal or ethnographic accounts of pedagogical change and were conducted by a single researcher without inter-rater reliability estimates. Therefore, observation-based insights should be interpreted as illustrative support for the broader survey and interview findings and not as stand-alone evidence of pedagogical culture.

Given these limitations, these findings should be interpreted as diagnostic evidence rather than evaluative outcomes. Future work can extend this study through participatory co-design processes with students and teachers, as well as through the longitudinal implementation of the VLE to examine its impact on language learning, digital competence, and teaching practice. Comparative studies of PD models may further clarify which forms of support most effectively sustain inclusive DL in low-resource settings.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

MTVO co-designed the study with BLdBC, collected and analysed the data, and drafted the manuscript; BLdBC provided methodological guidance, supervision, and critical revisions. Both authors approved the final version.

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Earlier drafts of this manuscript were partially refined using the AI language model ChatGPT, and the final version underwent professional language editing. These services were used only to improve grammar and wording. The authors remain fully responsible for the intellectual content, analysis, and final version of the manuscript, and ensured that their use did not compromise academic integrity.

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