



ICT use intensity and perceived learning support: A decoupling in Spanish compulsory education

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ABSTRACT

The integration of information and communication technologies (ICT) into compulsory education raises the question of whether more intensive technology use translates into a more favorable appraisal of its contribution to learning. This study analyzed the relationship between ICT use intensity and a set of objective and perceptual indicators in 1,969 primary (n = 868) and lower secondary students (n = 1,101) from several Spanish autonomous communities. A cross-sectional, non-experimental quantitative design was applied, analyzing a composite use intensity index through Chi-square and Kruskal-Wallis tests with effect sizes and through ordinal logistic regression models controlling educational stage and gender. Use intensity showed large associations with objective indicators of technology use and consistent differences by educational stage and school year, whereas gender exerted only a marginal influence. No association was found between use intensity and the perception that technology supports learning, even after adjusting for these covariates, whereas small positive associations emerged with specific indicators of decision-making capacity and desired learning. Primary students, despite less intensive use, appraised the educational usefulness of technology more favorably than secondary students. The findings support a decoupling between use intensity and perceived educational value and underline the relevance of pedagogical mediation over mere technological exposure.

Keywords: educational technology, ICT use, digital competence, primary education, secondary education, student perceptions

INTRODUCTION

The incorporation of information and communication technologies (ICT) into schooling has substantially transformed the way in which children and adolescents relate to knowledge, to their peers and to the school itself. This transformation has not been accompanied, however, by an equivalent consensus regarding its effects on learning, nor regarding the way in which such use varies across the successive stages of compulsory schooling. Whereas the availability of digital devices in Spanish schools has reached practically universal

levels, recent educational research makes clear that the mere presence of technology says little in itself about the quality of the learning experiences that derive from it. It is therefore necessary to shift the focus from questions concerning access towards questions concerning the intensity, the purpose and the educational meaning that students themselves attribute to their use of ICT, bearing in mind that such meaning is not necessarily the same in primary education as in lower secondary education. The sections that follow address this question, starting from a review of the literature that grounds both the multidimensional nature of ICT use and the reasons why relevant differences between educational stages and student profiles may be expected.

From Technological Availability to Digital Practices

The integration of ICT into educational settings has grown exponentially in recent years, largely as a consequence of two factors: the development of institutional digitalization mechanisms and the intense process of technological adaptation prompted by the COVID-19 pandemic (Gregersen et al., 2023; Wang et al., 2024; Wong, 2023; Zhou et al., 2024). These changes have in turn shifted the perspective from which studies on ICT use are framed, moving from approaches centered on access towards perspectives focused on students' digital experiences. ICT use has thus become a multidimensional construct that transcends the mere presence of devices or the amount of screen exposure. Recent literature stresses that digital practices must be analyzed through several variables: frequency of use, intensity of interaction, diversity of platforms and the purposes associated with those practices (Consoli et al., 2023; Johar et al., 2023; Tarifa-Rodríguez et al., 2024). Students with comparable levels of access may therefore develop markedly different educational experiences. Use intensity integrates not only exposure time but also connection frequency, number of applications and variety of activities (Consoli et al., 2023; Msambwa & Daniel, 2024), an aspect particularly relevant at school ages, where digital practices combine academic, communicative, social and recreational purposes.

The assumption whereby younger students handle technology intuitively and homogeneously by the mere fact of having grown up surrounded by digital devices has been subject to substantial critical revision. Kirschner and De Bruyckere (2017) question precisely the digital native assumption, pointing out that early exposure does not necessarily imply superior digital competence, since such competence depends on specific educational and contextual factors. This qualification is pertinent when comparing the two stages of compulsory education, which present developmental, curricular and autonomy differences that condition how students relate to technology irrespective of accumulated exposure time.

This transition towards greater technological autonomy also finds support in research on the development of self-control during adolescence. Burnell et al. (2023) document that, at around twelve years of age, coinciding with the move to secondary education, there is a marked increase in mobile device ownership and in the autonomy adults grant to minors in their use, at a moment when self-regulation capacities are still consolidating. This coincidence grounds the expectation of substantial differences in the intensity and nature of ICT use between primary and secondary students. In practice, greater independence displaces use purposes from educational and recreational applications towards platforms oriented to communication and content consumption. Research has also documented differentiated attitudinal profiles between boys and girls in aspects such as use dependence or perceived parental control (Mulero-Henríquez et al., 2024), differences smaller in magnitude than those associated with educational level but sufficient to treat gender as a relevant, albeit secondary, variable.

Educational Impact of ICT: Potential and Constraints

Research conducted over the past decade has generated abundant evidence of the educational effects derived from the use of digital technologies. Most of this work shows that ICT use can foster more dynamic, interactive and participatory learning experiences when integrated through active methodologies and learner-centered approaches (Kerimbayev et al., 2023; López-Sánchez et al., 2023; Otto et al., 2023; Ribeiro-Silva et al., 2022; Silva et al., 2022). Ley et al. (2021) stress that the effective appropriation of technology-mediated knowledge depends on explicit modelling and support from teachers, without which digital resources tend to generate superficial uses.

More specifically, recent studies underline that digital technologies may increase motivation, academic engagement and participation. David and Weinstein (2023), drawing on self-determination theory, show that digital tools produce positive effects especially when they promote autonomy, cooperation and active participation, whilst Li et al. (2024) conclude that interactive digital experiences favor engagement and mediate the motivational processes linked to learning. Systematic reviews further point to favorable results regarding the personalization of learning and educational inclusion: Ruijia et al. (2025) identify positive effects on knowledge acquisition, and Soriano-Sánchez (2025) highlights the potential of ICT to increase motivation and emotional involvement in contexts of attention to diversity. These effects presuppose a minimum level of digital literacy, an issue already raised by Buckingham (2006) when warning that widespread access to digital media does not guarantee the capacity to use it critically. The benefits associated with autonomy and self-regulation likewise depend on structured pedagogical contexts and adequate teacher mediation (Faza & Lestari, 2025; Khor & Mutthulakshmi, 2024; Prasse et al., 2024; Varona-Klioukina & Engel, 2024).

Despite these positive results, the empirical evidence continues to yield ambiguous conclusions regarding the impact of ICT on learning and academic achievement. Hall and Lundin (2024) find no significant improvements in academic outcomes derived from one-to-one device provision programs in primary education, and recent reviews indicate that the educational effectiveness of ICT depends on pedagogical, methodological and organizational factors rather than on mere availability (Msambwa & Daniel, 2024). Ertmer (1999) already distinguished between first-order barriers, linked to access and resources, and second-order barriers, tied to pedagogical beliefs and teaching practices, arguing that it is the latter that most strongly condition meaningful integration. Contemporary research therefore rejects techno-deterministic interpretations whereby the incorporation of technology automatically produces educational improvements. Selwyn (2023) raises this criticism of educational techno-solutionism, arguing that resolving learning problems through the simple introduction of technology ignores the complexity of the processes involved, which clarifies why positive results in dimensions such as motivation do not always translate into improvements in perceived learning.

Use Intensity and Educational Value: A Decoupling Hypothesis

Educational research has begun to question the existence of a linear relationship between increased ICT use and improved learning. Although many studies continue to employ quantitative indicators such as exposure time, frequency of use or device availability, these variables display weak or inconsistent associations with educational outcomes when not accompanied by appropriate pedagogical strategies (Consoli et al., 2023; Msambwa & Daniel, 2024). From this viewpoint, the educational value of ICT depends essentially on the quality of its pedagogical integration. Abedi (2023) notes a significant gap between the institutional expectations associated with educational digitalization and the practices actually developed in classrooms, where technologies continue to support traditional teaching procedures. Gil-Flores et al. (2024) show that deployed practices, rather than declared methodological orientations, determine how technology is used, and Toma et al. (2023) conclude that much integration corresponds to superficial uses that reinforce pre-existing teaching models.

Several studies have also warned of the risks associated with high levels of technological exposure. Hyperconnectivity, digital multitasking and continuous device use may negatively affect attention and concentration when adequate self-regulation mechanisms or pedagogical designs oriented towards meaningful learning are absent (Goagoses et al., 2024; Martin et al., 2025; Pérez-Juárez et al., 2023). To this is added a phenomenon recently described as technological normalization. According to Moorhouse et al. (2023) and Otto et al. (2023), the generalization of digital technologies has reduced the novelty effect associated with their use, so that its educational value comes to depend increasingly on the quality of the pedagogical experiences generated. Taggart and Roulston (2024) describe this through the metaphor of a Goldilocks zone, in which teachers' digital competence is located neither at an extreme of deficiency nor at one of full mastery, but in a variable state dependent on each teaching context.

A line of research has thus emerged that posits a possible decoupling between the intensity of technological resource use and perceived educational value. From this perspective, greater exposure to ICT does not necessarily entail a more favorable appraisal of learning or a higher perception of educational usefulness; the benefits appear to depend on the pedagogical purpose of the activities, the degree of active

participation, teachers' digital competence and the methodological coherence of learning experiences. Analyzing use intensity and educational perceptions jointly is therefore relevant for understanding the relationships between technology, learning, motivation and autonomy across educational stages.

Objectives and Hypotheses

The general objective of this study is to analyze the relationship between ICT use intensity and the variables associated with its use and perception in compulsory education students. Three specific objectives derive from it: to identify differences in ICT use intensity according to educational level, school year and gender; to examine the association between ICT use intensity and objective indicators of technology use, in terms of exposure time, frequency of use, number of applications, activities carried out and subjects involved; and to analyze the relationship between ICT use intensity and a set of perceptual indicators linked to the educational process, referring both to the perception that technology supports learning and to specific aspects of motivation and students' decision-making capacity over the use of technological resources in the classroom.

Four research hypotheses were formulated.

- H₁:** differences exist in ICT use intensity according to educational level, school year and gender, although the magnitude of these differences is expected to vary substantially across variables.
- H₂:** ICT use intensity is significantly associated with objective indicators of technology use, including screen exposure time, frequency of use, number of applications employed, activities carried out and subjects involved.
- H₃:** ICT use intensity is not significantly associated with students' perception that technology contributes to their learning.
- H₄:** ICT use intensity is significantly associated with specific indicators of motivation and decision-making capacity over the use of technology in the classroom, even in the absence of an association with the perception of learning support.

METHOD

Design and Instrument

The study follows a cross-sectional, non-experimental design aimed at analyzing the relationship between ICT use intensity and a set of variables associated with its use and perception in the educational context. Drawing on data gathered through a structured questionnaire, an analytical approach based on between-group comparison, on the examination of associations between variables and on multivariable ordinal regression models was developed, without direct intervention on the conditions under which the phenomenon studied occurs.

An ad hoc instrument was designed within the framework of the research in order to analyze ICT use among compulsory education students and their perceptions in relation to the learning process. The questionnaire was structured into three thematic blocks: sociodemographic and contextual variables (age, gender, school year and geographical origin); technology use indicators (screen exposure time, frequency of use, number of applications and activities carried out through digital devices); and perceptual indicators linked to the educational context, each measured through a single item and detailed in [Table 1](#). Items combined single-choice questions, multiple-choice questions and five-point Likert-type items depending on the nature of the variable. The final instrument comprises 18 items and is provided as supplementary material.

The instrument underwent a content validation process through expert judgement in order to ensure conceptual adequacy, item clarity and internal coherence. Ten academic specialists from the fields of education and the social sciences assessed the theoretical relevance and formal quality of the instrument. A content validity index (CVI) was calculated per item. Since the appraisal form used a three-category scale (acceptable, improvable, and remove) rather than the four-point Likert scale customary in the classical procedures of Lawshe (1975) or Polit and Beck (2006), an ad hoc weighting was established for each category

Table 1. Operationalization of the study variables

Type	Variable	Operational definition	Measure	Scale	Hypothesis
Main independent	ICT use intensity	Composite index of student technology use, standardized; recoded into three levels (low, medium, high) for bivariate analyses and used as a continuous score in regression models	Tercile classification/continuous score	Ordinal/continuous	H₁, H₂, H₃, H₄
Independent	Screen use hours	Daily exposure time to digital devices outside school	Categorical item	Ordinal	H₂
Independent	Frequency of ICT use	Number of moments or situations in which students use digital devices	Count/categories	Ordinal	H₂
Independent	Number of applications	Quantity of digital applications employed by students	Application count	Discrete	H₂
Independent	Number of ICT activities	Number of activities carried out through digital devices	Activity count	Discrete	H₂
Independent	Number of subjects with ICT use	Number of subjects in which digital devices are used	Subject count	Discrete	H₂
Dependent	Perceived learning support	Extent to which students consider that ICT use contributes to their learning	Likert item	Ordinal (1-5)	H₃
Dependent	Wish to participate more actively	Degree to which students would like to participate more directly in the development of lessons	Likert item	Ordinal (1-5)	H₃
Dependent	Enjoyment of lessons with technology	Appraisal of enjoyment of lessons in which technology is used	Likert item	Ordinal (1-5)	H₄
Dependent	Capacity to decide how to use technology	Perceived capacity to decide how to use technology in the classroom	Likert item	Ordinal (1-5)	H₄
Dependent	Perception of learning what one would like	Extent to which students perceive that they learn what they would like through ICT use	Likert item	Ordinal (1-5)	H₄
Dependent	Wish to choose learning content	Degree of student interest in being able to choose what to learn in class	Likert item	Ordinal (1-5)	H₄
Control	Educational level	Educational stage (primary/lower secondary)	Categorical item	Nominal	H₁
Control	School year	Academic year within each educational stage	Categorical item	Ordinal	H₁
Control	Gender	Student gender identification	Categorical item	Nominal	H₁
Control	Age	Age of participating students	Self-report	Continuous	-

Note. The ICT use intensity index was constructed by standardizing the objective indicators of use; it was classified into empirical terciles (33rd and 66th percentiles of the distribution) for the bivariate analyses and used as a continuous score in the regression models; All perceptual variables were measured through single questionnaire items; Their internal consistency was insufficient to justify a composite score (Cronbach's $\alpha = .47$ for the six perceptual items and .34 for the four items grouped under **H₄**), so they were analyzed separately and should be interpreted as specific indicators rather than as measures of latent constructs such as autonomy or motivation

(acceptable = 1; improvable = 0.5; remove = 0), and the CVI of each item was computed as the mean (M) of the weightings obtained across the experts who rated that item.

The global CVI for the student block, calculated over the 19 items originally submitted for appraisal, was 0.942, with per-item values ranging from 0.812 to 1.000. The only item below the rest (name of the school; CVI = 0.812) was flagged by several experts as liable to generate a risk of participant identification and was consequently removed from the final version of the questionnaire. The remaining items obtained CVI values equal to or above 0.889, exceeding the threshold of 0.78 usually recommended in the content validity literature (Lynn, 1986; Polit & Beck, 2006) for instruments assessed by ten or more judges, although this threshold was originally formulated for four-point scales and is applied here as an orientation. Not all experts rated every item, so the number of judgements considered in each CVI ranged from 8 to 10.

Study Variables

The variables directly linked to the objectives and hypotheses were selected from the data collection instrument. The main variable was ICT use intensity, constructed from a composite index and subsequently recoded into three levels (low, medium, and high) through empirical terciles. In its categorized form, this

Table 2. Distribution of students by school year and gender according to educational level

School year		Female n	Female %	Male n	Male %	Other n	Other %	Total n
Primary education	Year 3	79	58.5	54	40.0	2	1.5	135
	Year 4	125	59.8	83	39.7	1	0.5	209
	Year 5	163	50.5	159	49.2	1	0.3	323
	Year 6	109	54.2	89	44.3	3	1.5	201
	Total	476	54.8	385	44.4	7	0.8	868
Lower secondary education	Year 1	167	48.1	174	50.1	6	1.7	347
	Year 2	141	42.7	181	54.8	8	2.4	330
	Year 3	118	53.6	100	45.5	2	0.9	220
	Year 4	108	52.9	89	43.6	7	3.4	204
	Total	534	48.5	544	49.4	23	2.1	1,101

Note. Percentages are calculated over the total of each school year and, in the total rows, over the total of each educational level; The category other includes non-binary or unspecified responses; Row percentages refer to each school year (e.g., 79/135 = 58.5%), not to the educational level

variable structured the comparative analysis between groups, whereas in its continuous form it was entered as predictor in the ordinal regression models of the perceptual items.

Objective indicators of technology use were incorporated as independent variables: screen exposure time, frequency of use, number of applications employed, activities carried out and subjects in which digital devices are used. Six single-item perceptual indicators linked to the educational context were also considered, distinguishing two blocks with differentiated expected behavior: perceived learning support and the wish to participate more actively, for which the absence of a significant association with use intensity is posited (**H₃**); and four items conceptually related to motivation and decision-making capacity, namely enjoyment of lessons with technology, the capacity to decide how to use technology, the perception of learning what one would like and the wish to choose learning content, for which a significant association is posited even in the absence of that association with the direct perception of learning support (**H₄**). Sociodemographic control variables (educational level, school year, gender, and age) were also included. **Table 1** summarizes the operationalization of the study variables.

Participants

The sample comprised 1,969 students from primary education (n = 868), years three to six, and lower secondary education (n = 1,101), years one to four, drawn from several Spanish autonomous communities. Mean age was 9.8 years in primary education (standard deviation [SD] = 1.14) and 13.6 years in lower secondary education (SD = 1.29), with moderate variability at both levels. The analysis of variance (ANOVA) applied to age by gender showed no statistically significant differences at either level, which supports age homogeneity between gender subgroups within each educational level and ensures the comparability of subsequent analyses.

The distribution by school year shows greater representation at intermediate levels, particularly in year five of primary education and years one and two of lower secondary education, which favors the stability of the analysis and avoids extreme concentrations at specific levels (**Table 2**). Regarding gender, the sample is relatively balanced at both levels, with a somewhat higher proportion of girls in primary education (54.8%) and an almost even distribution in lower secondary education (48.5% girls and 49.4% boys, respectively). Participation was obtained from schools that agreed to collaborate, without random selection, which places the sample within a non-probabilistic convenience framework. The sample size and diversity of profiles nonetheless permit consistent comparative analyses, although this must be borne in mind when assessing the generalization of the results.

Procedure

The instrument was implemented digitally and distributed through a mailing addressed to school management teams in different autonomous communities. Schools were selected according to their fit with the stages of compulsory education and to the diversity of ownership types present in the Spanish education system. Prior to data collection, participating schools managed the study information and the corresponding informed consent with students' families, guaranteeing at all times the voluntary nature of participation and the possibility of not completing the questionnaire. Completion took place within the classroom, in

coordination with teachers, reserving a brief interval during lesson time and without modifying ordinary classroom conditions, which situates data collection in a natural setting.

The questionnaire was sent to 622 schools, of which 19 (8 secondary and 11 primary) finally took part, representing a school-level response rate of 3.05%. The sample was made up of 1,969 students, with a mean of approximately 103 responses per participating school. Data collection took place during the 2022-2023 academic year under the informed consent procedure described above.

Data Analysis

Data analysis followed a sequential statistical strategy aimed at characterizing the sample, exploring the distribution of the variables and analyzing the relationships between ICT use intensity and the set of variables considered. Prior to the statistical analyses, a composite index of ICT use intensity was constructed by standardizing the objective indicators of technology use gathered in the questionnaire. This index was subsequently classified into three levels (low, medium, and high) through an empirical tercile criterion, calculated from the 33rd and 66th percentiles of the distribution of the standardized index in the total sample, in order to guarantee the transparency and replicability of the segmentation process.

In the first phase, descriptive analyses were performed to characterize the sample, computing frequencies, percentages, means and SDs. A comparison of means through ANOVA was then carried out to verify age homogeneity between groups by gender within each educational level, thereby ruling out age as a potential confounding variable. Associations between ICT use intensity levels and the remaining categorical variables were subsequently analyzed through Pearson's Chi-square test, which was retained because these variables are categorical and the test provides a direct assessment of independence without assuming interval-level measurement. In order to assess the magnitude of the observed associations beyond their statistical significance, effect size measures were calculated according to the type of test applied: Cramér's V for all Chi-square tests, complemented by Goodman and Kruskal's gamma as a directional measure for the associations between use intensity and the objective indicators of use, all of which are ordinal, and epsilon squared (ϵ^2) for the Kruskal-Wallis tests. Effect magnitude was interpreted following the conventional criteria of small, moderate and large established for each coefficient. Given the ordinal character of the variables compared, the Kruskal-Wallis test was employed to analyze differences across the three use intensity levels. Since bivariate tests on the categorized index do not allow the influence of covariates to be controlled, hypotheses **H₃** and **H₄** were additionally tested through proportional-odds ordinal logistic regression, fitting one model for each perception item with the continuous use intensity index, computed as the mean of the standardized scores of the five objective indicators and re-standardized for these models, as predictor and educational level and gender as covariates. The proportional-odds assumption was examined through binary logistic regressions at each cut-point, model fit was summarized through Nagelkerke's R^2 , and a Bonferroni correction was applied across the six regression models ($\alpha = .008$). ANOVA and its multivariate extension were not employed for the perceptual outcomes because they are single ordinal items that do not meet the interval-level measurement assumption those procedures require. Descriptive and bivariate analyses were performed with IBM SPSS Statistics (version 29) and the ordinal regression models with the statsmodels library (version 0.15) in Python, setting a significance level of $p < .05$.

RESULTS

Sample Profile

Mean age was 9.8 years in primary education (SD = 1.17 for girls; SD = 1.09 for boys) and 13.6 years in lower secondary education (SD = 1.31 for girls; SD = 1.28 for boys), with approximately symmetrical distributions across all gender groups. An ANOVA by gender within each educational level showed no statistically significant differences either in primary education, $F(2, 865) = 0.301$, $p = .740$, or in lower secondary education, $F(2, 1098) = 1.208$, $p = .299$, which allows age to be discarded as a confounding variable and reinforces comparability between the groups analyzed ([Table 3](#)).

Regarding distribution by school year, primary education shows greater representation in year five (37.2%), followed by year four (24.1%) and year six (23.2%), whilst year three presents a smaller presence

Table 3. One-way ANOVA for age by gender within each educational level

Level	Source	Sum of squares	df	Mean square	F	p
Primary	Between groups	0.781	2	0.390	0.301	.740
	Within groups	1,122.937	865	1.298		
	Total	1,123.718	867			
Secondary	Between groups	4.051	2	2.025	1.208	.299
	Within groups	1,840.741	1,098	1.676		
	Total	1,844.792	1,100			

Note. df: Degrees of freedom; Dependent variable: Student age

Table 4. ICT use intensity level (empirical terciles)

Level	Frequency	Percentage (%)	Valid percentage (%)	Cumulative percentage (%)
Low ICT intensity	499	25.3	25.3	25.3
Medium ICT intensity	982	49.9	49.9	75.2
High ICT intensity	488	24.8	24.8	100
Total	1,969	100	100	

Note. Tercile classification was performed empirically from the distribution of the total sample (N = 1,969); The deviation from a strictly equitable segmentation (33.3% per level) is due to the presence of repeated index values around the cut-off points, and not to an error in the calculation procedure

(15.6%). In lower secondary education the sample concentrates mainly in year one (31.5%) and year two (30.0%), with lower representation in year three (20.0%) and year four (18.5%). The territorial distribution shows differentiated patterns between levels. In primary education the sample is spread relatively evenly across autonomous communities, concentrating in the Community of Madrid (31.1%), the Region of Murcia (22.8%), La Rioja (17.7%) and Castilla-La Mancha (16.1%). In lower secondary education, by contrast, the Community of Madrid accounts for 48.0% of the sample, followed by Castilla y León (16.6%), Castilla-La Mancha (11.3%) and the Region of Murcia (10.8%). This difference in territorial concentration introduces a possible uncontrolled confounding factor in the primary-secondary comparisons, insofar as contextual factors such as regional technological provision, regional education policy or socioeconomic environment may overlap with the differences attributed to educational level. This issue is revisited in the limitations section.

ICT Use Intensity

ICT use intensity was analyzed through a standardized composite index ($M = 0.00$; $SD = 0.63$), constructed from the main indicators of technology use. In order to guarantee comparability and robustness in the classification process, intensity levels were defined through an empirical tercile criterion calculated from the distribution of the index in the total sample (N = 1,969). Cut-off points were established at the 33rd and 66th percentiles, which allowed the sample to be segmented into three intensity levels: low (≤ -0.43), medium (between -0.43 and 0.43) and high (≥ 0.43).

The resulting distribution showed a marked predominance of the medium use level ($n = 982$; 49.9%), against smaller and mutually similar proportions at the low ($n = 499$; 25.3%) and high ($n = 488$; 24.8%) levels (Table 4). This over-representation of the medium level is explained by the presence of a high number of tied values around the center of the distribution of the standardized index, derived from the categorical nature of several of the objective indicators that compose it: the 33rd and 66th percentiles fall within a zone of high density of repeated values, which concentrates in the medium level a number of cases higher than would be expected under a strictly continuous distribution. Despite this asymmetry, the classification retains sufficient variability for comparative analysis, although the unequal distribution of cases across categories must be considered when interpreting the statistical contrasts that employ this variable.

Use Intensity and Structural Variables

A statistically significant association was observed between educational level and ICT use intensity, $\chi^2(2, N = 1,969) = 32.30$, $p < .001$, with a small effect size ($V = .13$). Secondary students present a higher proportion of high intensity levels compared with primary students, where low and medium levels predominate. Regarding gender, a statistically significant association was identified, $\chi^2(4, N = 1,969) = 11.85$, $p = .019$, although the effect size was small ($V = .06$), indicating a weak relationship between the two variables. The analysis by school year evidenced a significant association, $\chi^2(14, N = 1,969) = 80.50$, $p < .001$, with a small to moderate effect

Table 5. Chi-square tests for ICT use intensity level by sociodemographic variables

Variable	χ^2	df	p	Effect size
Educational level	32.30	2	< .001	V = .13
Gender	11.85	4	.019	V = .06
School year	80.50	14	< .001	V = .14

Note. df: Degrees of freedom; V: Cramér's V; Values of p are reported to three decimal places; values below .001 are expressed as < .001

Table 6. Chi-square and Kruskal-Wallis tests for ICT use intensity by objective indicators of use

Variable	χ^2	df	p	V	γ	H (K-W)	ϵ^2	p (K-W)
Screen use hours outside school	696.70	6	< .001	.42	.70	620.30	.32	< .001
Number of ICT use frequencies	648.41	8	< .001	.41	.76	541.23	.28	< .001
Number of applications employed	994.21	46	< .001	.50	.68	758.20	.39	< .001
Number of ICT activities	1,022.07	18	< .001	.51	.74	817.68	.42	< .001
Number of subjects with ICT use	451.35	30	< .001	.36	.52	378.84	.21	< .001

Note. df: Degrees of freedom; V: Cramér's V; ϵ^2 computed as $H/(N-1)$; γ : Goodman and Kruskal's gamma; K-W: Kruskal-Wallis test with df = 2 in all cases; Values of p are reported to three decimal places; values below .001 are expressed as < .001

size (V = .14), showing a progressive trend towards higher intensity levels as the school year advances, especially in secondary education (Table 5).

These data indicate that educational level and school year act as relevant differentiating factors in ICT use intensity. The association with gender, although statistically significant, presents an effect size below the conventional threshold of practical relevance, and must therefore be interpreted with caution: its statistical significance is largely attributable to the large sample size rather than to a substantive difference between genders in ICT use intensity.

Use Intensity and Objective Indicators of Technology Use

Associations between ICT use intensity and the objective indicators of technology use were analyzed through Pearson's Chi-square test, incorporating effect size measures in order to estimate the magnitude of the relationships observed. As a complementary analysis that exploits the ordinal information of the indicators, the Kruskal-Wallis test was additionally applied to each indicator, since it allows verification of whether the mean rank of those variables differs significantly across the three use intensity levels.

The results show statistically significant associations in all the indicators analyzed, with large effect sizes in most cases, and the Kruskal-Wallis tests yielded a consistent pattern (Table 6). A strong relationship was observed between ICT use intensity and screen use hours outside school, $\chi^2(6, N = 1,969) = 696.70$, $p < .001$, $V = .42$, $\gamma = .70$, indicating a progressive increase in use intensity as exposure time rises. Consistently, the number of use frequencies showed a large-magnitude association, $\chi^2(8, N = 1,954) = 648.41$, $p < .001$, $V = .41$, $\gamma = .76$, evidencing that greater frequency of interaction with devices is directly linked to higher intensity levels. The number of applications employed also yielded a significant association, $\chi^2(46, N = 1,965) = 994.21$, $p < .001$, $V = .50$, $\gamma = .68$, although the breadth of categories in this variable generates a high number of cells with low expected frequencies. The number of activities carried out through ICT presented one of the most robust associations in the study, $\chi^2(18, N = 1,969) = 1022.07$, $p < .001$, $V = .51$, $\gamma = .74$, suggesting that the diversification of uses constitutes a determining factor in overall use intensity. Finally, the number of subjects in which digital devices are used showed a significant association of moderate magnitude, $\chi^2(30, N = 1,781) = 451.35$, $p < .001$, $V = .36$, $\gamma = .52$, again with cells of low expected count in some categories. The asymmetry in the size of the three intensity levels contributes to the appearance of cells with low expected frequencies in those variables with a larger number of categories, so the results corresponding to the number of applications and the number of subjects must be interpreted with the additional caution this entails. Taken together, these results evidence that ICT use intensity is closely linked to the objective indicators of technology use, especially in variables related to frequency, diversity of activities and exposure time, and the consistency between the Chi-square and Kruskal-Wallis results supports the stability of these relationships.

Use Intensity and Perceptual Variables

The relationship between ICT use intensity and students' perceptual variables does not present a homogeneous pattern. In particular, no statistically significant association was observed between use

Table 7. Differences in perceptual variables by ICT use intensity level (Kruskal-Wallis test)

Variable	H	df	p	ϵ^2	Significant differences
Perceived learning support	1.59	2	.453	.001	No
Capacity to decide how to use technology	8.99	2	.011	.005	Yes
Enjoyment of lessons with technology	8.42	2	.015	.004	Yes
Wish to participate more actively	0.37	2	.831	< .001	No
Perception of learning what one would like	8.12	2	.017	.004	Yes
Wish to choose learning content	16.06	2	< .001	.008	Yes

Note. df: Degrees of freedom; ϵ^2 computed as $H/(N-1)$; Values of p are reported to three decimal places; values below .001 are expressed as < .001; Significant differences were determined with a criterion of $\alpha = .05$

Table 8. Ordinal logistic regression of perceptual items on ICT use intensity, educational stage and gender (N = 1,969)

Perception item	Use intensity OR [95% CI]	p	Secondary OR [95% CI]	p	Nagelkerke R ²
Perceived learning support	1.06 [0.97, 1.15]	.183	0.51 [0.43, 0.61]	< .001	.036
Wish to participate more actively	1.05 [0.97, 1.14]	.263	0.72 [0.61, 0.84]	< .001	.011
Capacity to decide how to use technology	1.12 [1.04, 1.22]	.004	0.89 [0.76, 1.05]	.158	.006
Enjoyment of lessons with technology	0.98 [0.89, 1.07]	.639	0.73 [0.61, 0.88]	.001	.008
Perception of learning what one would like	1.20 [1.10, 1.30]	< .001	0.57 [0.48, 0.68]	< .001	.031
Wish to choose learning content	1.23 [1.13, 1.35]	< .001	0.94 [0.79, 1.12]	.486	.012

Note. Proportional-odds models; Use intensity was entered as the continuous standardized index (OR per standard deviation); secondary education is compared with primary education; All models control gender; Bonferroni-corrected significance threshold: $\alpha = .008$

intensity and the perception that technological tools contribute to learning, $\chi^2(8, N = 1,969) = 8.52, p = .384, V = .05$, which indicates that greater use of technology does not necessarily translate into a more favorable appraisal of its educational usefulness. The Kruskal-Wallis test yielded a consistent result, showing no significant differences between intensity levels in the variable technological tools help learning, $H(2) = 1.59, p = .453, \epsilon^2 = .001$.

By contrast, significant differences were identified in other perceptual variables. Differences were observed in the perceived capacity to decide how to use technology in the classroom, $H(2) = 8.99, p = .011, \epsilon^2 = .005$, and in enjoyment of lessons in which technological resources are employed, $H(2) = 8.42, p = .015, \epsilon^2 = .004$. Likewise, the perception of learning what one wishes to learn through ICT use showed significant differences, $H(2) = 8.12, p = .017, \epsilon^2 = .004$, together with the wish to choose learning content, $H(2) = 16.06, p < .001, \epsilon^2 = .008$. Conversely, the wish to participate more actively in class showed no significant differences according to ICT use intensity, $H(2) = 0.37, p = .831, \epsilon^2 < .001$ (Table 7). At the bivariate level, ICT use intensity thus appears to be related to specific items concerning choice over technology use, enjoyment of technology-supported lessons and desired learning, but not to the direct perception of improved learning; the multivariable models reported below examine whether these associations hold once educational stage and gender are controlled.

Ordinal Regression Models for Perceptual Variables

Once educational stage and gender were controlled (Table 8), use intensity remained unassociated with perceived learning support (odds ratio [OR] = 1.06, 95% CI [0.97, 1.15], $p = .183$) and with the wish to participate more actively (OR = 1.05, $p = .263$), and showed small positive associations with the capacity to decide how to use technology (OR = 1.12, $p = .004$), the perception of learning what one would like (OR = 1.20, $p < .001$) and the wish to choose learning content (OR = 1.23, $p < .001$). The association with enjoyment of technology-supported lessons was not maintained (OR = 0.98, $p = .639$). Secondary students showed lower odds of favorable responses in four of the six items, and the variance explained was small in all models (Nagelkerke's $R^2 \leq .036$).

Comparison Between Primary and Secondary Education

The comparative analysis between educational stages shows consistent differences in use patterns and in the appraisal of technology. Secondary students present a higher proportion of cases at the high use intensity level than primary students, $\chi^2(2, N = 1,969) = 32.30, p < .001, V = .13$ (Table 5). This difference is accompanied by longer daily screen exposure, $\chi^2(3, N = 1,969) = 154.42, p < .001, V = .28$, and by a higher number of use

Table 9. Number of applications employed by educational stage

Stage	Low 0-1 (%)	Medium 2-3 (%)	High 4 or more (%)
Primary education	8.3	19.5	72.2
Lower secondary education	4.3	20.8	74.9

Note. Number of applications selected by each student; $\chi^2(2, N = 1,969) = 13.92$; $p < .001$; $V = .08$

Table 10. Percentage use of platforms and applications by educational stage

Platform/tool	Primary education (%)	Lower secondary education (%)
TikTok	36.87	40.87
Instagram	28.80	38.15
WhatsApp	33.41	41.78
YouTube	35.71	36.33
Games	32.26	19.98
Educational	17.28	9.08
None	0.92	0.18

occasions, $\chi^2(5, N = 1,969) = 64.18$, $p < .001$, $V = .18$, whereas the number of applications employed differed only slightly between stages, $\chi^2(2, N = 1,969) = 13.92$, $p < .001$, $V = .08$ (Table 9). Secondary students also reported a higher self-perceived ability to use all the applications on their devices (91.4% against 81.5% in the two highest response categories), $\chi^2(4, N = 1,969) = 46.54$, $p < .001$, $V = .15$.

Differences are also observed in the nature of the applications used (Table 10). In secondary education, platforms linked to communication and digital content consumption gain weight, with increases in TikTok (36.87% to 40.87%), Instagram (28.80% to 38.15%) and WhatsApp (33.41% to 41.78%), whilst primary education retains a greater relative presence of educational applications (17.28% against 9.08% in secondary education) and of recreational ones (32.26% against 19.98%).

In relation to the perceptual items, primary students present more favorable appraisals of the educational usefulness of technology, with 55.2% declaring that technology helps their learning a great deal, against 38.1% in secondary education, $\chi^2(4, N = 1,969) = 63.37$, $p < .001$, $V = .18$. Analogous results are observed in enjoyment of lessons in which technological resources are employed, $\chi^2(4, N = 1,969) = 13.93$, $p = .007$, $V = .08$, and in the wish to participate more actively in class, $\chi^2(4, N = 1,969) = 56.63$, $p < .001$, $V = .17$. Significant differences were also identified in the perceived capacity to decide on the use of technology in the classroom, $\chi^2(4, N = 1,969) = 13.08$, $p = .011$, $V = .08$, and in the wish to choose what to learn, $\chi^2(4, N = 1,969) = 21.09$, $p < .001$, $V = .10$, although in these two items the differences concerned the distribution of responses rather than their central tendency. ICT use intensity therefore increases consistently on moving from primary to secondary education, together with a displacement in the purpose of use from the educational and recreational towards the social and communicative, whilst the subjective appraisal of the contribution of technology to learning follows the inverse pattern, being more favorable precisely in the stage where use is less intensive.

Hypothesis Testing

Regarding **H₁**, the results support the hypothesis. The three structural variables showed significant associations with ICT use intensity (educational level: $\chi^2(2, N = 1,969) = 32.30$, $p < .001$, $V = .13$; school year: $\chi^2(14, N = 1,969) = 80.50$, $p < .001$, $V = .14$; gender: $\chi^2(4, N = 1,969) = 11.85$, $p = .019$, $V = .06$), although with clearly differentiated magnitudes: educational level and school year presented small to moderate effect sizes, whereas gender showed a marginal one, as the hypothesis anticipated.

With respect to **H₂**, the results support the hypothesis. The five objective indicators analyzed showed significant associations with moderate to large effect sizes (V between .36 and .51; γ between .52 and .76), with consistent results in the Kruskal-Wallis tests. As for **H₃**, the results likewise support the hypothesis. No significant association was observed between use intensity and perceived learning support, either through Chi-square ($\chi^2[8, N = 1,969] = 8.52$, $p = .384$, $V = .05$) or through Kruskal-Wallis ($H = 1.59$, $p = .453$), and the absence of association was maintained in the ordinal regression model controlling for educational stage and gender (OR = 1.06, 95% CI [0.97, 1.15], $p = .183$). The same pattern was observed for the wish to participate more actively in class, which was also assigned to **H₃** ($H = 0.37$, $p = .831$; OR = 1.05, $p = .263$). This is the central finding on which the decoupling hypothesis posited in the theoretical framework is articulated.

Finally, **H₄** is partially supported. At the bivariate level, significant differences by intensity level emerged in the four indicators that compose it: perceived capacity to decide on the use of technology ($H = 8.99, p = .011$), enjoyment of technology-supported lessons ($H = 8.42, p = .015$), perception of learning what one wishes to learn ($H = 8.12, p = .017$) and the wish to choose learning content ($H = 16.06, p < .001$). Once educational stage and gender were controlled, use intensity remained positively associated with the first, third and fourth of these indicators (OR between 1.12 and 1.23), but not with enjoyment of technology-supported lessons (OR = 0.98, $p = .639$), and the magnitude of these associations was small in all cases.

DISCUSSION

The general objective of this study is considered to have been fully achieved, with the three specific objectives supported by the results. The differences in use intensity by educational level, school year and gender (**H₁**), the consistent association between that intensity and the objective indicators of technology use (**H₂**), and the differentiated pattern observed in the perceptual items, with no association regarding perceived learning support, even once educational stage and gender were controlled, and only small associations with specific indicators of decision-making capacity and desired learning (**H₃** and **H₄**), coherently support the decoupling hypothesis: greater use intensity is closely associated with students' reported technology use, but does not in itself guarantee a more favorable appraisal of its contribution to learning. This is consistent with the critique of techno-determinism developed by Selwyn (2023) and with the evidence of Msambwa and Daniel (2024), according to which the educational effectiveness of ICT depends on pedagogical, methodological and organizational factors rather than on mere availability.

The results relating to educational level and school year confirm that the school stage constitutes the most relevant structural variable in the configuration of use patterns, in line with Kirschner and De Bruyckere's (2017) critique of the digital native myth: it is not chronological age or accumulated exposure that explain the differences observed, but developmental and contextual factors that modulate students' relationship with technology differently at each stage. Beyond the quantitative increase in intensity, the results evidence a qualitative change in the purpose of use: the proportion of students employing educational applications is practically halved between stages, recreational applications decrease even more sharply, and communication platforms gain weight systematically. This functional reorientation is coherent with the technological normalization posited by Moorhouse et al. (2023) and Otto et al. (2023): as technology use becomes generalized and loses its novel character, its purpose shifts from instrumental and educational uses towards social and recreational ones. The multivariable models reinforce this reading, since educational stage was significantly associated with students' perceptions in four of the six items, whereas use intensity was not associated with the perceived contribution of technology to learning once stage was controlled.

The difference observed in the subjective appraisal of the contribution of technology to learning between stages constitutes one of the most pronounced gaps in the whole study. A plausible explanation, coherent with the framing of technological normalization, is that this difference reflects, at least partially, the loss of the novelty effect as technology use consolidates into an everyday practice in secondary education, rather than a real change in its pedagogical usefulness. This interpretation finds indirect support in the literature on educational gamification, where Ratinho and Martins (2023) document that the motivation associated with technological tools tends to decline with prolonged exposure, even when those tools retain their objective functionality intact. The cross-sectional character of the present design nonetheless prevents a precise distinction between a developmental effect associated with age and a cumulative effect derived from greater exposure, so this interpretation must be understood as a hypothesis to be tested in future longitudinal studies, and not as a conclusion established from the available data.

As regards gender, although a statistically significant association with use intensity was identified, its effect size proved marginal. This illustrates a well-documented phenomenon: with large sample sizes, practically any minimal difference between groups attains statistical significance without necessarily implying a substantive difference (Sullivan & Feinn, 2012). By systematically incorporating effect size measures alongside significance tests, the analytical design has allowed this over-interpretation to be avoided and suggests that gender should not be considered a determining factor in the configuration of ICT use patterns, in line with

the generally small magnitude of gender differences documented by Mulero-Henríquez et al. (2024) in samples of similar ages.

The findings carry relevant implications for educational practice. If use intensity does not in itself guarantee a more favorable perception of the contribution of technology to learning, the challenge does not lie in increasing exposure but in pedagogically qualifying it. Raave et al. (2024) show, in a study with primary and secondary teachers, that classroom patterns of technological integration depend not so much on the teacher's instrumental familiarity with digital tools as on their pedagogical intentionality and on the coherence with which those tools are articulated with learning objectives, which situates the responsibility for translating use intensity into educational value fundamentally in teacher mediation rather than in the students themselves.

Limitations and Future Research

First, the cross-sectional and non-experimental design prevents causal relationships from being established between ICT use intensity and the perceptual variables analyzed. The differences observed between primary and secondary education, particularly the gap in the subjective appraisal of the contribution of technology to learning, admit alternative explanations that the present design cannot discriminate, among them a developmental effect associated with age, a cumulative effect derived from technological exposure, or a combination of both. Future longitudinal studies following the same students across the transition from primary to secondary education would be particularly suitable for disentangling this question.

Second, the sample was obtained through a non-probabilistic convenience procedure, which limits the representativeness and generalization of the results. This limitation is compounded by the unequal concentration of the secondary education sample in the Community of Madrid, against a more balanced territorial distribution in primary education, which introduces a possible uncontrolled confounding factor in the comparisons between stages. Future research should prioritize probabilistic sampling procedures stratified by autonomous community, allowing statistical control of the influence of contextual and regional factors such as regional technological provision or territory-specific education policies.

Third, the perceptual variables were measured through single self-report items, and their internal consistency was insufficient to combine them into composite scores (Cronbach's $\alpha = .47$; see [Table 1](#)), which is why they were analyzed separately as specific indicators. This approach, whilst keeping the instrument brief and appropriate for the ages of the participating students, does not capture the complexity of constructs such as autonomy or motivation, so the associations reported for these items should not be generalized to those constructs as a whole. The development and validation of multi-item scales for these dimensions constitutes a pending line of work, which would allow the decoupling hypothesis to be tested on psychometrically robust measures.

Fourth, the asymmetry in group sizes derived from the tercile segmentation of the use intensity index, together with the high dimensionality of some categorical variables, generated a non-negligible number of cells with low expected frequencies in certain Chi-square contrasts. Although these results were consistent with the Kruskal-Wallis tests and, for the perceptual items, were further examined through ordinal regression models treating use intensity as a continuous variable, future studies could benefit from alternative categorization criteria for the objective indicators of use. In addition, students were nested within schools, and this clustering was not modelled; multilevel approaches would allow school-level variance to be separated from individual-level associations. Finally, the study focused exclusively on the perspective of students, without incorporating information from teachers or families, despite the fact that the results point to teacher mediation as a determining factor. Future research combining student data with teacher data on technological integration practices would allow direct examination of whether the quality of that mediation explains the differences observed in students' perceptions.

CONCLUSIONS

This study analyzed the relationship between ICT use intensity and a set of objective and perceptual indicators in a large sample of primary and lower secondary education students in Spain. The results provide empirical support for the decoupling hypothesis: technological use intensity is consistently associated, with

large effect sizes, with objective indicators of use, but is not associated with students' perception of the contribution of technology to their own learning, even when educational stage and gender are considered. This result, obtained convergently through bivariate non-parametric tests and ordinal regression models, constitutes the central contribution of the study and indicates that the volume of technological exposure and its perceived educational value are distinct dimensions whose relationship cannot be taken for granted in the design of educational policies or practices.

The study also confirms that educational stage and school year, rather than gender, act as the main differentiating factors in the configuration of technology use patterns. The transition from primary to secondary education is not limited to a quantitative increase in use intensity but entails a qualitative reorientation of its purpose, shifting progressively from educational and recreational uses towards communicative and social ones. Read through the lens of technological normalization, this transformation offers a plausible explanation for the most striking finding of the study: that it is precisely primary students, with less intensive use, who sustain a more favorable appraisal of the educational role of technology, whilst secondary students, more exposed and more competent in its instrumental handling, appear comparatively more skeptical about its usefulness for learning. These results support approaches that question techno-deterministic interpretations of educational change and reinforce the need to place the quality of pedagogical mediation, rather than the quantity of technological exposure, at the center of research on ICT and learning.

In practical terms, the absence of an association between use intensity and perceived learning warns against educational policies oriented primarily towards increasing provision and exposure time without equivalent attention to the quality of pedagogical integration. Interventions should instead be directed towards strengthening teacher mediation and towards fostering uses of technology that give students greater choice over how they use it and over what they learn, aspects in which small but significant associations with use intensity were identified. This orientation is especially pertinent during the transition from primary to secondary education, a moment at which the progressive autonomy of students in handling technology coincides with a decline in their educational appraisal of it, and at which intentional pedagogical support could help to sustain the link between technology use and meaningful learning that dilutes as schooling advances.

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AI statement: During the preparation of this manuscript, the authors used the artificial intelligence assistant Claude (Sonnet 5, Anthropic) as a support tool at various stages of writing and revision. Specifically, it was used to: (a) support the conceptual alignment between the study variables and the analytical factors considered; (b) improve the clarity and coherence of the analytical model and the overall organization of the manuscript; and (c) provide linguistic suggestions aimed at improving readability and consistency in the explanation of theoretical constructs. All outputs generated with the support of this tool were reviewed, verified and validated by the authors, who assume full responsibility for the final content of the manuscript, including the accuracy of the data, the original statistical analyses of the study (conducted using IBM SPSS Statistics, not through artificial intelligence), the interpretation of the results and the conclusions. The use of this tool is declared in accordance with current recommendations on transparency in scientific research regarding the use of generative artificial intelligence systems in the preparation of academic manuscripts.

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