PIXEL-BIT
e-ISSN: 2171-7966
REVISTA DE MEDIOS Y EDUCACIÓN
MEDIA & EDUCATION JOURNAL

Impact of ICT on Motivation and Learning in Primary Education: Towards an exciting school

Impacto de las TIC en la motivación y el aprendizaje en educación primaria: Hacia una escuela emocionante

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Received: 2025-03-13; **Reviewed:** 2025-11-20; **Accepted:** 2025-11-21; **Published:** 2026-01-01

ABSTRACT

This study analyzes the impact of Information and Communication Technologies (ICT) on the motivation and learning of primary education students through a longitudinal quasi-experimental design that compares a pedagogical intervention based on ICT, gamification, and Game-Based Learning (GBL) with the results of a similar study conducted a decade earlier. The intervention was structured around a gamified interactive digital object and assessed through a digital questionnaire measuring students' perceptions of ICT use, motivation, and academic performance. The results show that, although technological intermediation continues to have a positive influence on motivation, its current impact depends more on the methodological and emotional design of the pedagogical proposal than on the mere presence of digital tools or devices. The study provides a replicable model of technopedagogical integration and introduces the concept of *affective digital literacy*, concluding that ICT is a valuable tool only when implemented through active, gamified strategies that are contextually adapted to the characteristics of each school and student group.

RESUMEN

Este estudio analiza el impacto de las Tecnologías de la Información y la Comunicación (TIC) en la motivación y el aprendizaje de estudiantes de educación primaria mediante un diseño cuasi-experimental longitudinal que compara una intervención pedagógica basada en TIC, gamificación y Aprendizaje Basado en Juegos (ABJ) con los resultados de un estudio similar realizado una década antes. La intervención se articuló en torno a un objeto digital interactivo gamificado y se evaluó mediante un cuestionario digital que midió la percepción del uso de las TIC, la motivación y el rendimiento académico. Los resultados muestran que, si bien la intermediación tecnológica sigue influyendo positivamente en la motivación, su impacto actual depende más del diseño metodológico y emocional de la propuesta que de la mera presencia de dispositivos o recursos digitales. El estudio aporta un modelo replicable de integración tecnopedagógica y apunta hacia la noción de alfabetización digital afectiva, concluyendo que las TIC son una herramienta valiosa solo cuando se incorporan a través de estrategias activas, gamificadas y contextualizadas a las características de cada centro y grupo de alumnado.

KEYWORDS · PALABRAS CLAVES

Educational innovation; Technology intermediation; Educational engagement; Educational achievement; Active learning; Active learning
Innovación educativa; Intermediación tecnológica; Compromiso educativo; Rendimiento escolar; Aprendizaje activo

1. Introduction

Although relatively recent, emotions have gradually become a central axis in scientific research related to education. For centuries, they remained relegated to the background in favor of rationalist and empiricist approaches that dominated scientific inquiry. However, the term *"emotions"* has progressively gained relevance in educational literature, reflecting a growing interest among researchers (e.g., Rebollo et al., 2008; Méndez-Aguado et al., 2020; Casanova-Mata, 2023; Quílez-Robles et al., 2023). Today, the educational field faces a paradox: despite the increasing attention given to emotions, interdisciplinary studies remain scarce. Neuroscience, psychology, sociology, communication, and education each examine emotions from their own epistemological and ontological frameworks, producing a fragmented analysis that limits a comprehensive understanding of their role in learning.

The etymological meaning of *emotĭo* refers to a "movement toward" or "impulse," and has been categorized in various ways. Casassus (2007) proposes a typology based on the feelings associated with emotions, distinguishing between positive, negative, and neutral emotions. Positive emotions—such as happiness—are linked to pleasant sensations that generate beneficial situations. Conversely, negative emotions—such as anxiety or fear—are associated with discomfort and perceived threat. Unlike other authors, Casassus introduces a third category: neutral emotions, including surprise or hope, which lack a clear emotional valence and align more closely with the original notion of impulse.

The influence of emotions on behavior and learning is essential, as they directly shape how knowledge is assimilated. Studies in neuroscience, psychology, and education demonstrate that learning depends not only on cognitive ability but also on emotional and motivational factors (Tyng, 2017; Tan et al., 2021; Gkintoni et al., 2023; Astleitner, 2000). Camacho-Morles et al. (2021) argue that interest and the need for information condition the acquisition of knowledge: enjoyment fosters academic performance, whereas boredom or frustration have a detrimental effect. This interplay between emotion and cognition explains how actions, thoughts, and memories rely on the synchronisation of both systems.

Pekrun et al. (2002) further confirmed this relationship by challenging the traditional view that educational success depends solely on intelligence, highlighting instead the importance of motivation and interest in constructing meaningful learning. Recent research reinforces this perspective, underscoring that learning extends beyond memorisation and requires a balance between emotional and cognitive processes to be effectively consolidated (Camacho-Morles et al., 2021; Tan et al., 2021; Lozano-Fernández et al., 2000).

1.1. Emotions and academic performance

Learning is intrinsically linked to emotions. As Mora (2013) famously asserts, *"one can only learn what one loves."* Goleman (1996) reinforces this by arguing that life success depends 80% on emotional intelligence and only 20% on cognitive intelligence—an idea applicable to the educational domain. Pekrun (1992) identifies emotions as a core component of student psychology, connecting them to motivation and cognitive strategies that influence academic performance. Contemporary studies consolidate this connection (Tyng et al., 2017; Tan et al., 2021; Gkintoni et al., 2023; Astleitner, 2000), while De Sitxe and Sánchez (2014) describe cognition, motivation, and emotion as interdependent determinants of learning

1.2. Motivation in the classroom

Motivation plays a fundamental role in learning, influencing cognition, memory, and behavior (Roman, 2022; Sánchez-Sánchez et al., 2020; Polaino-Lorente, 2011). According to Polaino-Lorente (op. cit.) and Ausubel's (1960) theory of meaningful learning, students only feel motivated when they perceive an actual usefulness in the task they are performing. Although the concept of motivation is complex, most studies agree in defining it as the set of processes that activate, direct, and sustain behavior (Bekker et al., 2023; Feraco et al., 2023).

From an educational perspective, two main types of motivation are distinguished: intrinsic motivation, linked to personal interest and self-regulated learning (Howard et al., 2021), and extrinsic motivation, determined by external factors such as rewards or sanctions (Anaya-Durand & Anaya-Huertas, 2010; Schunk & Dibenedetto, 2020). Intrinsic motivation has been shown to promote deeper and more lasting learning compared to extrinsic motivation (Buzdar et al., 2017; Rinaudo et al., 2006). Stipek (1988) points out that students' interest in the task influences the prevailing type of motivation, highlighting the role of the teacher in planning instructional strategies that foster enthusiasm and active involvement in the learning process.

1.3. The affective role of ICT in education

Dewey (1995) argued that the school environment should balance play and work to support children's development. This idea remains relevant in educational technology research, which highlights the positive impact of ICT on motivation and academic performance (Bekker et al., 2023; Camacho-Morles et al., 2021; Méndez-Aguado, 2020; Muñoz-Millet, 2023). Victoria-Maldonado (2024) notes that ICT integration in the classroom encourages dynamic and interactive learning experiences, facilitates access to information, and generates flexible and adaptive environments (Cabero-Almenara, 2003). Nevertheless, Area (2009) warns that these resources should be considered as more than simple information transmission tools, while Siraj-Blatchford and Romero-Tena (2017) emphasize the need to incorporate ICT progressively to promote playful learning environments.

However, their implementation requires a methodological shift that fosters active student participation (Moya, 2013). Requena (2008) and Trujillo-Torres et al. (2020) argue that ICT enrich educational experiences by involving students meaningfully in their own learning. Nonetheless, Parra-González et al. (2020) caution that the mere introduction of technology in the classroom does not guarantee improvements in learning. Coll (2008) emphasizes that its pedagogical potential lies in the teacher's instructional strategy rather than in the technology itself. Thus, it is necessary to adopt innovative approaches that promote interaction, creativity, and collaboration. Correct ICT integration will enable new forms of teaching aligned with the educational demands of the 21st century.

1.4. Background of the research

The quasi-experimental study carried out in 2014 at the Tierno Galván Public School in Granada analyzed the relationship between emotions, ICT use, and academic performance in the educational context. The sample included 38 students aged 8 and 9 years, divided into an experimental group of 18 students and a control group of 20 students, selected

intentionally to ensure homogeneity in variables such as socioeconomic level and academic background. The methodology sought to minimize the influence of external factors and focus on the impact of ICT and emotions on learning.

To collect the data, a questionnaire with 43 simple items and Likert-scale questions was designed, evaluating motivation, emotions, and students' perception of learning with ICT. Its development included prior analysis of similar instruments and validation by a panel of experts in education and psychopedagogy, who made adjustments to improve clarity and precision.

The results showed significant differences between the two groups, indicating that integrating digital resources in the classroom, combined with a methodology focused on motivation and emotions, had a positive impact on learning and emotional well-being. The experimental group experienced a reduction in negative emotions such as disappointment and boredom, accompanied by a considerable increase in motivation. Regarding academic performance, this group obtained higher results in exams and evaluations, with an average of 9.33 out of 10, compared to 6.80 for the control group. Table 1 summarizes the main findings, highlighting the influence of ICT on the level of enjoyment and motivation among students.

Table 1

Results of the 2014 study

Variables	**Pretest Results**		**Post-test Results**	
	Control Group Results	Experimental Group Results	Control Group Results	Experimental Group Results
Enjoyment_ICT	NO – 35,0% NO – 16.7%	YES - 65,0% SÍ - 83,3%	NO - 35,0% NO - 11,1%	SÍ - 65,0% SÍ - 88,9%
Variables	Control Group		Experimental Group	
Motivation_Use_PC	NO – 45%	SÍ - 55%	NO – 16,7%	SÍ - 83,3%
Academic performance	6, 80 point out of 10		9,33 point out of 10	

Despite the favorable results, the study presented some limitations, such as the insufficient availability of technological resources in the school, which hindered optimal implementation of the methodology. In addition, some students lacked technological devices at home, generating a digital divide that affected equal access to educational resources. Despite these difficulties, the findings indicate that strategic ICT integration, combined with adaptive methodologies, can be an effective tool to improve motivation and academic performance. Future research should explore best practices for technology integration in education, considering not only available resources but also the socioemotional context of students.

This study differs from previous research by combining emotional, technological, and pedagogical perspectives in the analysis of learning in primary education. It offers an innovative view of ICT use by integrating the affective and motivational variable into a

longitudinal quasi-experimental design, replicating a previous study and updating its results in a context of consolidated digitalization. Based on this, the present research adopts a quasi-experimental exploratory approach and seeks to examine the impact of using technological educational resources in primary classrooms, within an affective approach based on emotions. From this framework, three research questions arise:

PI1: Does the use of technology in the classroom predispose students' emotional states?

PI2: Does the methodological variant generate differences in the learning acquired between the groups participating in the study?

PI3: Is there evidence of changes in the results throughout the ten years since the implementation of the previous study?

2. Method

This study seeks to evaluate the effectiveness of an innovative pedagogical proposal that integrates technological resources and playful strategies to optimize the understanding of scientific concepts in third-grade primary education students. It analyzes the impact of this intervention on the learning of theoretical content, comparing the results with those obtained in a similar study conducted in 2014. The research examines whether the integration of technology and playful pedagogical methodologies has fostered more meaningful and lasting learning, in contrast to traditional approaches, and how its effectiveness has evolved considering changes in access to and use of ICT in the last decade.

The study was developed in two phases. The first phase, descriptive in nature and with a qualitative approach, consisted of a detailed analysis of the attitudes, emotions, and initial perceptions of the students regarding the subject of Natural Science. For this purpose, a questionnaire created with Microsoft Forms was used, whose objective was to evaluate students' perception of ICT use within the classroom. Specifically, the questionnaire sought to determine whether students considered that the use of ICT, especially educational video games, could be useful for their learning in the Natural Science subject. Additionally, the questionnaire included questions about the degree of acceptance of ICT and students' perception of the subject before and after the technological intervention. The objective was to measure whether the incorporation of these digital tools, such as educational video games, increased interest and improved the perception that students had of the subject.

In the second phase, with a comparative and quantitative approach, differences between the control group (3ºA) and the experimental group (3ºB) were evaluated, within an intervention design in which active methodologies such as gamification and Game-Based Learning (GBL) were incorporated. In the experimental group, an interactive digital object was used, designed with tools such as Genially and Canva, which allowed the integration of different resources such as educational videos, interactive activities, and games related to the subject and created specifically for this purpose, all within the same digital object. The interface of this digital object was structured in the form of a video game, in which students advanced through levels of learning related to the contents of the Natural Science subject. This approach allowed students to engage actively in the learning process, with a playful integration of content that fostered intrinsic motivation, collaboration, and critical thinking. The use of this interactive digital object enabled students to visualize complex concepts

dynamically and participate in practical exercises, promoting collaborative learning and deeper engagement with the content.

To ensure accurate evaluation of the variables, a detailed or "fine-grained" analysis approach was applied, enabling a rigorous comparison of the impact of the methodology on learning and motivation. This included measuring the frequency of ICT use, the types of activities performed (collaborative work, educational games, online research), and the results obtained in pre- and post-tests, with special attention to how these resources supported autonomy and interest in learning.

2.1. Instrument

Two different instruments were used in this study: (1) an evaluation instrument, consisting of a digital questionnaire designed to measure the motivation and perception of students regarding the use of ICT in the classroom; and (2) a pedagogical intervention instrument, represented by an interactive digital object that was used exclusively with the experimental group as part of the teaching process.

2.1.1. Evaluation instrument: digital questionnaire

The first instrument consisted of a questionnaire administered through Microsoft Forms, designed to evaluate the perception of students regarding the use of ICT in the classroom, their motivation toward the Natural Science subject, and their interest in technological resources in educational contexts. Its structure was based on two main dimensions: ICT-guided learning and motivation or engagement.

In addition to measuring the general perception of students regarding ICT, the questionnaire included specific items related to the resources used in the practice. Specifically, it evaluated the perceived usefulness of the digital object, the level of enjoyment and concentration experienced during the interactive activities, and the relevance of educational video games as a means to learn content from Natural Science. This direct correspondence between the instrument and the technological experience made it possible to analyze accurately how the integration of ICT influenced motivation and learning, offering a deeper understanding of the pedagogical role of digital resources in the classroom.

The instrument used in this study was an adaptation of a questionnaire previously validated in 2014, designed to evaluate the motivation and attitude of students toward the Natural Science subject, with a focus on ICT use. The validation process of the adapted instrument was carried out in various stages, following rigorous procedures to ensure its reliability and validity in the context of this new study. These stages included validation by expert judgment, contextual adjustments to the instrument to ensure its applicability to the new group of students, and construct validation through Exploratory Factor Analysis (EFA).

In the first stage of the validation process, the instrument was evaluated by a panel of experts in the field of education and educational technology. These experts, with extensive experience in the field of student motivation and ICT implementation in the classroom, were responsible for reviewing the content of the questionnaire and ensuring that the items were relevant, clear, and appropriate to measure the constructs of motivation and attitude in the educational context. This process of expert judgment validation made it possible to ensure the content validity of the instrument, since the experts confirmed that the questionnaire

items addressed relevant aspects related to ICT use and student motivation in Natural Science. Additionally, this step ensured that the items were understandable and appropriate for third-grade primary education students, which was a fundamental requirement to ensure that participants could interpret the questions properly.

2.1.2. Adaptation to the educational context and lexical adjustments

With the aim of optimizing the applicability of the instrument to the new context, lexical and structural adjustments were made to the questionnaire. Since the target population of this study consisted of third-grade primary education students, the wording of the questionnaire was reformulated to adapt it to the comprehension level of the participants. These modifications involved simplifying the wording of certain items and eliminating terms that were complex or technical, which could hinder students' understanding. Additionally, redundant items that did not contribute significant additional information were removed, and the five-point Likert response categories from the original instrument were maintained. This adjustment was performed to ensure that students could respond accurately and meaningfully, while preserving consistency with the design of the questionnaire used in the previous study. Despite the modifications, the general structure of the questionnaire was preserved, with the aim of maintaining longitudinal comparability between the results of this study and those obtained in the 2014 study.

To confirm that the instrument adequately measured the dimensions of motivation and attitude toward the Natural Science subject, a construct validation was conducted through Exploratory Factor Analysis (EFA). This statistical technique allowed verification that the questionnaire items grouped coherently into the predetermined dimensions of motivation and attitude, as established in the original design of the instrument. The EFA made it possible to identify underlying dimensions and verify that the items aligned with the theoretical constructs, providing statistical evidence for the construct validity of the adapted instrument. The results of the EFA confirmed that the questionnaire items grouped correctly into the dimensions of motivation and attitude, supporting the effectiveness of the instrument for measuring these aspects in the educational context. To ensure that the results of the present study were comparable to those obtained in the previous study conducted in 2014, the general structure of the adapted instrument was preserved. The structure of the questionnaire remained without significant changes, maintaining the grouping of items into the same dimensions and response categories. This decision allowed the results of the present study to be compared longitudinally with the data obtained in the earlier research, facilitating a deeper understanding of changes over time in relation to ICT use and student motivation. By preserving the original structure of the instrument, data consistency was ensured and a valid and meaningful comparison of findings across the years was made possible.

In summary, the validation process of the adapted instrument was based on a rigorous approach combining multiple methods, including expert judgment validation, contextual adjustments, and statistical construct validation through Exploratory Factor Analysis. These steps ensured that the adapted instrument was valid, reliable, and appropriate for measuring the constructs of motivation and attitude toward the Natural Science subject in the current educational context, while also enabling a valid comparison with the results obtained in the 2014 study.

2.1.3. Intervention instrument: interactive digital object

The second instrument[1],, pedagogical in nature and non-evaluative, consisted of an interactive digital object designed with Genially and Canva, implemented exclusively with the experimental group as part of the instructional intervention. This resource integrated explanatory videos, interactive activities, gamified challenges, and mini-games within the same environment, all of which were linked to the curricular contents of the Natural Science subject. Its structure was organized following a level-based playful narrative, in which each level corresponded to a thematic block of the curriculum (for example: ecosystems, animals, or nutrition). It was used during several consecutive 50-minute sessions, within the regular classroom schedule, completely replacing traditional expository methodology. In each session, students accessed the digital environment through individual computers and worked autonomously and under guidance, progressing in the game as they completed the activities. The explanatory videos introduced the theoretical concepts; the interactive activities allowed verification of content comprehension; and the challenges or mini-games reinforced learning through exploration and problem-solving dynamics.

The teacher acted as mediator and facilitator, guiding the instructional sequence, resolving questions, and encouraging peer collaboration. Students' progress was visually represented through badges, achievements, and unlocked levels, generating a more motivating and personalized learning experience. The design of the digital object was based on the principles of Game-Based Learning (GBL) and educational gamification, incorporating elements of immediate feedback, visual progression, and symbolic rewards to foster curiosity, autonomy, and enjoyment during the learning process. Overall, the incorporation of ICT in this intervention was not limited to the use of digital tools as a complement; instead, it constituted the central axis of the methodology, integrating technological resources into the classroom dynamics to stimulate emotional engagement and enhance students' intrinsic motivation.

2.2. Sample

The sample consisted of two natural groups of third-grade primary education students (3A and 3B) belonging to a two-line public school in the province of Almería. A total of 27 students participated (14 in the control group and 13 in the experimental group), aged between 8 and 9 years (Table 2). The distribution by sex was balanced: 54.8% male and 45.2% female.

The selection of the sample was carried out through non-probabilistic convenience sampling, based on criteria of accessibility to the educational center, the willingness of the teaching staff to participate in the research, and the socioeconomic and academic comparability with the previous study conducted in 2014. This sample sought to ensure the representativeness of the third-grade groups within the school, guaranteeing homogeneity of participants regarding cognitive, affective, and socioeconomic characteristics, which allows longitudinal comparison with the previous study. Non-probabilistic sampling is justified by the impossibility of conducting random sampling due to the characteristics of the educational context, a key aspect in studies like this, which aim to reflect classroom dynamics naturally. In the case of the primary education sample, two intact groups of students were selected without making artificial alterations to their composition. This design,

[1] Abalos Aguilera, F. (2025, enero 14). El mundo de los animales. Zenodo. https://doi.org/10.5281/zenodo.14647433

with intact groups, allowed the ecological validity of the study to be maintained, since the classes were not reorganized and the students continued with their usual educational dynamics. This made it possible to ensure longitudinal comparability between both investigations, facilitating the evaluation of the evolution of the effects of ICT on motivation and learning.

Table 2

Descriptive analysis of sex and age of the control and experimental groups

Year 2014			
Variable	***Control Grpup*** **N** 20	***Experimental Group*** **N** 18	***Total*** **N** 38
Sex	M = 55% F = 45%	M = 55.56% F = 44.44%	M = 55.26% F = 44.74%
Age	8.5 years (±0.7)	8.6 years (±0.8)	8.55 years (±0.75)
Year 2024			
Variable	***Control Grpup*** **N** 14	***Experimental Group*** **N** 13	***Total*** **N** 27
Sex	M = 50% F = 50%	M = 60% F = 40%	M = 54.84% F = 45.16%
Age	8.7 years (±0.6)	8.8 years (±0.7)	8.75 years (±0.65)

N = Number of students, M= Male, F= Female

The students were selected according to the following characteristics and criteria:

- Age: Participants were between 8 and 9 years old, corresponding to the age range of the third grade of primary education.
- Socioeconomic level and educational context: Two groups were selected with similar characteristics in terms of socioeconomic environment and academic level of the students, which allows an adequate comparison of the results.
- Parental authorization: Students had authorization from their legal guardians to participate in the study, ensuring compliance with the established ethical requirements.
- Curricular adaptations: In the event that any student presented curricular adaptations or specific educational needs, the availability of the necessary resources was guaranteed (adaptations to the questionnaire and additional resources), with the aim of ensuring that all participants could access the activities and tests with guarantees of success and equity.

In a quasi-experimental design, such as the present study, it is essential to control relevant variables that may influence the results. In this case, several of these variables were controlled to ensure the internal validity of the study and prevent possible external variables from affecting data interpretation:

- Teacher: Both groups were taught by the same teacher to eliminate any possible effect of variation in pedagogical style or teacher training, ensuring that the observed results were attributable exclusively to the pedagogical intervention.
- Schedule and curricular content: Both groups worked under the same class schedule and curricular programming for the Natural Science subject. This helped ensure that the learning content was the same for both groups, so that any difference in the results could not be explained by differences in the content taught.
- Technological resources: Although the experimental group used an interactive digital object and gamified resources, both groups had access to the same basic technological resources, such as computers and projectors, which ensured that the only difference between the groups was the methodology applied.
- School context and classroom environment: Both groups worked under similar classroom conditions, with the same physical environment and arrangement of material resources, which helped control possible external influences of the school context on the results obtained.
- Curricular adaptations and educational needs: In the event that any student had specific educational needs or curricular adaptations, it was ensured that they had the necessary resources and supports to participate under equal conditions, ensuring that the sample was equitable and representative.

The assignment of participants to the control and experimental conditions was carried out according to the natural organization of the groups in the educational center, that is, without modifying the structure of the classroom or performing random assignments. Group 3A followed a traditional expository methodology, while group 3B participated in the ICT- and gamification-mediated pedagogical intervention. Having the same teacher, the same curriculum, and the same instructional planning minimized the influence of external factors, ensuring that any difference between the groups was attributable exclusively to the intervention. Working with intact groups allowed the natural structure of the classes to be preserved, reducing administrative interference and ensuring that the results were as representative as possible of the usual educational environment. This reinforces the ecological validity of the study, since the results obtained reflect the real effects of the intervention in a typical school environment, with conditions similar to those of many primary education classrooms.

To evaluate the influence of the methodology on the retention and understanding of knowledge, the test included key aspects regarding the feeding and morphological adaptations of animals, examining the relationship between dentition, diet, and frequency of intake. Responses from both groups were compared to analyze whether the innovative methodology facilitated better assimilation of the content. Likewise, the impact of ICT on motivation and attitude toward the Natural Science subject was evaluated, determining whether the use of digital tools and playful dynamics increased students' interest.

In conclusion, this study made it possible to assess the dual influence of ICT on both knowledge acquisition and perception of learning, providing a reference framework for future research in primary education.

3. Analysis and results

This study analyzed the relationship between the use of ICT and student motivation, evaluating its impact on academic performance. The results reflect both significant and non-significant correlations between the variables, offering a nuanced view of the role of digital resources in learning processes and in the student's emotional and cognitive disposition toward school tasks.

One of the most relevant findings is the moderate positive correlation between motivation to learn with computers before and after the intervention (r = .385, p = .035). This result indicates a stable and coherent relationship between both measurements, suggesting that students who already showed a favorable predisposition toward ICT-mediated learning maintained or even increased their motivation after the intervention (Table 3). From a statistical perspective, this correlation explains approximately 15% of the shared variance, a value which, although moderate, is significant in the educational context and reinforces the idea that exposure to structured technological resources can strengthen positive attitudes toward learning. From a pedagogical standpoint, this significant association demonstrates that the incorporation of educational technology in the classroom has a positive effect on student motivation, reinforcing its role as a catalyst for student engagement and involvement. A higher level of motivation results in more active participation, greater persistence in the face of difficulties, and a more favorable emotional disposition toward learning. Consequently, the results highlight the need to integrate ICT into teaching methodologies not only as instrumental tools but as mediators of the motivational process, capable of activating intrinsic interest, curiosity, and the student's sense of competence, key factors for the consolidation of meaningful and sustainable learning.

Table 3

Motivation to learn with computers – pre and post test

		Motivation_learn_computer_Pre	Motivation_learn_computer_Post
Motivation_learn_computer_Pre	Pearson Correlation	1	.385*
	Sig. (two-tailed)		.035
	N	30	30
Motivation_learn_computer_Post	Pearson Correlation	.385*	1
	Sig. (Two-tailed)	.035	
	N	30	30

*. Correlation is significant at the 0,05 level (Two-tailed).

However, the correlation between preference for classes with computers before and after the intervention did not reach statistical significance (r = .109, p = .568), although the positive sign of the coefficient suggests a slight trend toward a more favorable evaluation of ICT-mediated learning (Table 4). From a statistical perspective, this weak correlation indicates that the intervention did not generate consistent changes in students' overall preference for classes with computers, which could be due to the stability of prior attitudes

or to the existence of external factors that moderate this relationship. This result can be understood as evidence of technological saturation: given that students already coexist daily with digital environments, their predisposition toward using computers in the classroom may have reached a motivational ceiling. In other words, the use of ICT ceases to be a novel element and becomes perceived as part of the usual learning context. This interpretation aligns with the ideas of authors such as Pekrun (2017), who emphasize that the academic emotion associated with a tool depends on its perceived value and the relevance that the student attributes to it within their school experience.

Likewise, the lack of statistical significance could reflect high interindividual variability in the perception of the usefulness of ICT, modulated by factors such as familiarity with digital resources, learning style, or the quality of pedagogical implementation. From an educational perspective, this finding suggests that the mere presence of computers in the classroom does not guarantee an improvement in students' motivation or preference, but rather that their effectiveness depends on how the resources are integrated into a coherent and emotionally meaningful instructional sequence. Consequently, the analysis points to the need to deepen studies that consider individual and contextual differences as mediating variables of the motivational impact of ICT.

Table 4

Perceived usefulness of audiovisual material in class (pre and post test)

		Videos_help_class_Pre	Videos_help_class_Post
Videos_help_class_Pre	Pearson Correlation	1	-.015
	Sig. (Two-tailed)		.938
	N	30	30
Videos_help_class_Post	Pearson Correlation	-.015	1
	Sig. (Two-tailed)	.938	
	N	30	30

3.1. Perceived usefulness of working with textbooks

The correlation between the perception of the usefulness of working with textbooks before and after the intervention was moderate (r = .331, p = .074), without reaching statistical significance (Table 5). This result suggests a relative stability in the evaluation of traditional materials, which reflects the persistence of their pedagogical value even in digital environments. From a didactic perspective, this stability can be interpreted as evidence of the functional coexistence between analog and technological resources. Students continue to consider the textbook as a safe and familiar support, associated with structured learning routines, while ICT are perceived as a playful and interactive complement. This finding is consistent with recent research advocating for a model of educational media ecology, in which the effectiveness of learning does not depend on replacing traditional resources, but rather on integrating them into hybrid sequences that combine structure, exploration, and emotion (Coll, 2008; Cabero-Almenara, 2003). In this sense, the lack of statistical variation does not imply an absence of change, but rather a balanced adaptation of students to the coexistence of both learning formats.

Table 5

Perceived usefulness of textbook use (pre and post test)

		Usefulness_textbook_work_Pre	Usefulness_textbook_work_Post
Usefulness_textbook_work_Pre	Pearson Correlation	1	.331
	Sig. (Two-tailed)		.074
	N	30	30
Usefulness_textbook_work_Post	Pearson Correlation	.331	1
	Sig. (Two-tailed)	.074	
	N	30	30

3.2. Use of audiovisual material in the classroom

The correlation between the perception of the usefulness of videos in class before and after the intervention was practically null (r = -.015, p = .938), indicating that their use did not generate changes in students' motivation or perception (Table 6). This result may be explained by a phenomenon of audiovisual saturation, derived from the daily overexposure to multimedia content outside the classroom. Students, accustomed to a constant digital consumption environment, may show a weaker emotional response to traditional audiovisual resources, perceiving them as passive elements within the learning process. From the perspective of the theory of academic emotions (Pekrun, 2017), positive emotion arises when educational material is perceived as novel, challenging, and relevant. In this case, the mere projection of videos does not necessarily meet these conditions if it is not integrated into an active learning sequence that stimulates reflection or participation. Therefore, the absence of statistical changes reinforces the need to design interactive audiovisual strategies, where the student assumes an active role in the interpretation and application of the content.

Table 6

Usefulness of videos in class (pre and post test)

		Videos_help_class_Pre	Videos_help_class_Post
Videos_help_class_Pre	Pearson Correlation	1	-.015
	Sig. (bilateral)		.938
	N	30	30
Videos_help_class_Post	Pearson Correlation	-.015	1
	Sig. (Two-tailed)	.938	
	N	30	30

3.3. Fun in class and computer use

The analysis of the relationship between fun in class and computer use revealed a moderate correlation (r = 0.135, p = 0.478), although without reaching statistical significance (Table 7). This suggests that, although some students experienced greater enjoyment in technology-based classes, this perception was not uniform across the entire sample. Fun is a key element for academic motivation, as it promotes active engagement in learning. The

lack of a significant effect could be due to individual differences in students' experiences or to the way ICT were implemented in teaching. These findings highlight the importance of designing pedagogical strategies that integrate technology in a structured and dynamic way, ensuring a positive impact on students' motivation and engagement. From the perspective of flow theory (Csikszentmihalyi, 1990), fun occurs when the challenge and the student's skills are balanced; in the absence of this balance, motivation decreases. This finding reinforces that technology, by itself, does not guarantee the creation of emotionally stimulating experiences: its motivational potential materializes only when it is framed within gamified or active learning environments. Consequently, the low correlation observed reflects more a diversity of subjective experiences than a failure of the methodology, pointing to the need to personalize the use of ICT according to students' styles, rhythms, and levels of digital competence.

Table 7

Perception of fun in class with the use of computers (pre and post test)

		Fun_class_teacher_computer_Pre	Fun_class_teacher_computer_Post
Fun_class_teacher_computer_Pre	Pearson Correlation	1	.135
	Sig. (Two-tailed)		.478
	N	30	30
Fun_class_teacher_computer_Post	Pearson Correlation	.135	1
	Sig. ()	.478	
	N	30	30

3.4. Correlation between teaching methodologies and performance (RQ2)

The results show that the application of methodologies based on ICT, gamification, and GBL favored better academic performance in the experimental group (3B) compared to the control group (3A). On average, students in the experimental group obtained a higher score (M = 5.77, SD = 1.59) compared to the mean of the control group (M = 4.79, SD = 1.89), reflecting a difference of 0.98 points (Table 8). Furthermore, the lower dispersion in the results of the experimental group indicates greater uniformity in performance, suggesting that these pedagogical strategies not only promote learning but may also contribute to reducing performance inequalities within the classroom.

Table 8

Statistical data for the control and experimental groups

Variable	Value
Course attended	3A
Test taken	Post-test
Variable	Valor
Course attended	3B
Test taken	Post-test

Descriptive Statistics

	N	Mean	Std. Dev	Min.	Max.		N	Media	Desv Std	Mín.	Máx.
Test Score	14	4.79	1.98	1	8	Test Score	14	4.79	1.98	1	8
Valid N (listwise)	14					Valid N (listwise)	14				
Missing N (listwise)	0					Missing N (listwise)	0				

In order to determine whether the implementation of ICT in the teaching–learning process has a significant impact on students' academic performance, the Student's t-test for independent samples was applied. This test made it possible to evaluate whether the difference between the means of the two groups was statistically significant (Table 9). Although the difference between means did not reach statistical significance ($t = –1.46$, $p = .157$), the calculation of effect size (Cohen's $d \approx 0.55$) allows the identification of a medium effect magnitude, which implies an educationally relevant improvement, although not statistically conclusive. This difference can be considered a moderate pedagogical effect, consistent with previous studies indicating that gamification and GBL produce sustained improvements in engagement and performance (Muñoz-Millet, 2023; Janous et al., 2022), especially in small samples or real classroom contexts.

Table 9

Independent Samples Test

Levene's Test for Equality of Variances			T-test for Equality of Means						
Test Score Content	F	Sing.	t	df	Sing. (2-colas)	Difer. Media	Err.Est .de la Diferencia	Intervalo de confianza de la diferencia 95%	
								Inferior	Superior
Equal variances assumed	.06	.814	-1.46	25.00	.157	-.98	.67	-2.37	.41
Equal variances not assumed			-1.47	24.78	.155	-.98	.67	-2.36	.40

To determine whether there are significant differences between both groups (control and experimental) regarding the effectiveness of the use of ICT, gamification, and GBL on performance, the following hypothesis system is established:

Null Hyphotesis (H0): There is no significant difference between the means of the two groups ($\mu_1 = \mu_2$).

Alternative Hyphotesis (H1): There is a significant difference between the means of the two groups ($\mu_1 \neq \mu_2$).

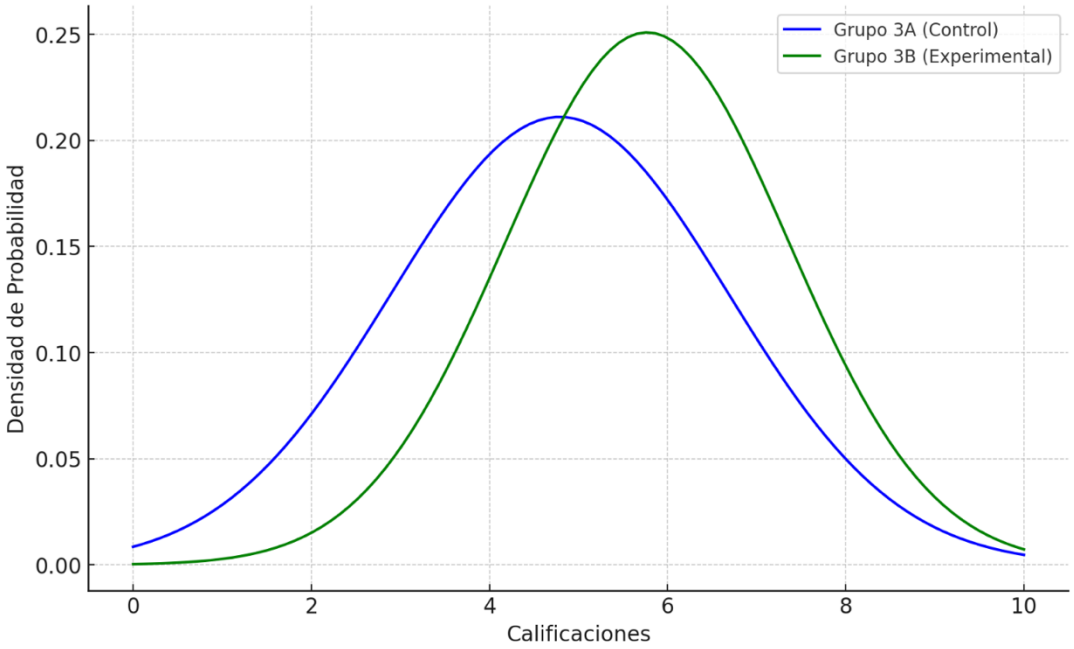
The statistical analysis carried out shows that, although the experimental group (3B) obtained higher academic performance than the control group (3A), the difference observed in the means (M = 4.79 in 3A and M = 5.77 in 3B) did not reach statistical significance, since the p-value obtained (.157) is above the conventional threshold of .05 (Table 9). This prevents rejecting the null hypothesis of equality of means and suggests that the difference could be associated with sample variability. However, if one considers the effect size, the contrast between both means presents a Cohen's d value of approximately 0.55, which is considered a medium effect size. From a pedagogical perspective, this effect size indicates that the ICT-, gamification-, and GBL-based intervention could be associated with a relevant improvement in performance, although the available sample (N = 27) does not offer sufficient statistical power to detect this difference with conventional significance. In this sense, the risk of Type II error (failing to find significant differences when they actually exist) is high, which reinforces the need to interpret the results with caution and to replicate the study with larger samples and longer intervention periods.

To reinforce the validity of the analysis, Levene's test was applied, confirming the homogeneity of variances between both groups, allowing for the appropriate use of the t-test. Although the mean difference of –.98 suggests a favorable trend toward the experimental group, the lack of statistical significance prevents drawing definitive conclusions about its impact on learning. However, the graphical representation of the normal distribution curve (Figure 1) and the Kolmogorov–Smirnov test provide a clearer view of the difference in absolute terms, indicating an improvement in the experimental group that, although not statistically significant, may have practical implications in the educational field. These findings highlight the need for future research with larger samples and robust

experimental designs that allow for more precise evaluation of the effect of ICT on academic performance, considering variables such as the duration of the intervention, the instructional methodology, and the effective integration of technological resources into the teaching–learning process.

Figure 1

Theoretical normal distribution of the scores (performance).



Source: own elaboration.

The analysis of the distribution of results represented in Figure 1 and Table 10 reinforces the patterns observed in the Student's t-test. Notable differences can be seen between both groups in terms of central tendency and dispersion: the control group (3A) obtained a mean of 4.79 with greater variability (SD = 1.89), while the experimental group (3B) reached a higher mean of 5.77 and lower dispersion (SD = 1.59), indicating more homogeneous scores and a tendency toward medium-high performance.

Although these differences did not reach statistical significance, the visual and descriptive analysis suggests the presence of a moderate educational effect, consistent with the previous inferential results. From a pedagogical perspective, the lower variability in the experimental group shows that the methodology based on ICT, gamification, and Game-Based Learning (GBL) not only favored the understanding of the content but also reduced the performance gap between students, promoting more equitable and stable learning. This finding aligns with recent research that highlights the capacity of active methodologies to homogenize student progress by integrating playful, collaborative, and continuous feedback components within digital learning environments.

Table 10

Results of the group

Content test score– Group 3A (Control)		
N		14
Normal Parameters	Mean	4.79
	Std. Dev	1.89
Most Extreme Differences	Absolute	.19
	Positiv	.12
	Negativ	-.19
Kolmogorov-Smirnov Z		.70
Asymp. Sig. (2-tailed)		.705

Content test score— Group 3B (Experimental)		
N		13
Normal Parameters	Media	5.77
	Desviación Estándar	1.59
Most Extreme Differences	Absoluto	.17
	Positivo	.15
	Negativo	-.17
Kolmogorov-Smirnov Z		.60
Asymp. Sig. (2-tailed)		.870

Both groups, 3A and 3B, presented p-values higher than 0.05 in the Kolmogorov–Smirnov test (Table 10), which confirms that the scores in both cases can be considered normally distributed at the 95% confidence level. This result validates the use of parametric tests, such as the Student's t-test, and reinforces the methodological soundness of the comparative analysis conducted in the previous section.

In summary, the statistical results offer a nuanced picture of the impact of the intervention. On the one hand, the significant correlations—such as the one observed between motivation to learn with computers before and after the intervention ($r = .385$, $p < .05$)—indicate that approximately 15% of the variability in motivation is consistently associated with the use of ICT, which supports their value as mediators of academic engagement. On the other hand, the lack of significance in other correlations (for example, the perceived usefulness of videos or the preference for classes with computers) and in the comparison of performance between groups suggests that the effect of ICT is not automatic or homogeneous, but dependent on methodological design, the type of resource used, and the context of application.

The combination of these trends—higher means in the experimental group, moderate effect size in performance, and greater homogeneity of results—points to a scenario of pedagogically relevant but statistically limited effects, consistent with the exploratory nature of the study. In this sense, the observed motivational stability and the reduction in score dispersion are indicators of qualitative improvement, even if they do not reach statistical significance. These findings justify interpreting the results from an educational rather than inferential perspective, highlighting the need to replicate the study with larger samples and experimental designs of greater power and control to confirm the robustness of the observed effects.

3.4. Longitudinal changes in the usefulness of ICT and active methodologies (RQ3)

In the last decade, the impact of technologies on education has undergone a profound transformation. While in 2014 the introduction of digital resources—such as computers, videos, or interactive whiteboards—generated an immediate motivational response, today their effect is more heterogeneous and dependent on the way they are pedagogically integrated. The results of the present study confirm this change. On the one hand, students

who already showed prior interest in ICT maintained stable levels of motivation, whereas those with lower predisposition did not show significant improvements, unlike what was observed a decade ago. This longitudinal variation suggests that technology has lost its novelty effect and that its motivational potential now depends on the methodological design and the degree of emotional engagement it promotes. In the case of educational videos, for example, their perceived usefulness has stabilized, reflecting saturation derived from continuous exposure to audiovisual content. Thus, fun and engagement are no longer automatically linked to the presence of digital resources, but rather to the way in which they are integrated into meaningful and participatory instructional sequences.

From a pedagogical perspective, these findings reinforce the importance of active methodologies such as gamification and Game-Based Learning (GBL). Far from conceiving technology as an end in itself, these strategies turn it into a means to activate cognitive, emotional, and social processes that support lasting learning. Their effectiveness lies in balancing challenge with students' skills—following Csikszentmihalyi's (1990) flow theory—and in promoting experiences that connect with students' interests and real contexts.

In conclusion, the results show an evolution in the relationship between technology, motivation, and learning. ICT maintain their pedagogical value, but their effectiveness requires planned, emotionally meaningful, and contextualized integration. This paradigm shift has direct implications for educational innovation: the teacher must assume the role of designer of learning experiences, combining digital resources and active methodologies to sustain students' intrinsic motivation. In future research, it would be relevant to analyze how variables such as students' degree of autonomy or the nature of the tasks influence this new motivational dynamic mediated by technology.

4. Discussion and conclusions

The results of the present study confirm that Information and Communication Technologies (ICT) continue to positively influence student motivation, particularly in the willingness to learn with computers. However, unlike previous studies in which the introduction of ICT in the classroom generated immediate improvements in emotional predisposition and academic performance, their current impact depends more on the quality of methodological implementation. This finding aligns with self-determination theory (Deci and Ryan, 2000), which holds that technologies only foster intrinsic motivation when they stimulate the student's autonomy, competence, and social connectedness. In this way, technology becomes a means to strengthen intrinsic motivation only when it is pedagogically integrated in a meaningful way. Otherwise, its influence is limited to an accessory and merely instrumental role, without a transformative effect on learning.

Consistent with Pekrun (2017), the non-significant nature of some correlations should not be interpreted as an absence of impact, but as evidence that emotions and instructional structure mediate the actual effectiveness of ICT in classroom contexts. For their part, the non-significant correlations in aspects such as preference for computer-based classes or the perceived usefulness of videos should not be understood as an absence of effect, but as evidence that the influence of ICT is mediated by emotional and didactic factors. In line with Pekrun's (2017) theory of emotions, these differences suggest that positive emotions associated with technology-mediated learning do not emerge automatically, but through sustained experiences that combine challenge, control, and enjoyment. Technology,

therefore, acts as an emotional catalyst only when framed within an instructional design that balances cognitive demands with students' competencies.

Performance results show moderate differences in favor of the experimental group, with lower dispersion in scores and a higher mean (M = 5.77, SD = 1.59) compared to the control group (M = 4.79, SD = 1.89). Although these differences did not reach statistical significance, their coherence with the motivational patterns observed allows for interpreting that active methodologies mediated by ICT foster more homogeneous and equitable learning. This finding is consistent with the classic—but still relevant—meaningful learning theory of Ausubel (1960), which holds that deep assimilation of knowledge occurs when new content is integrated with students' prior experiences.

In this case, gamification and Game-Based Learning (GBL) functioned as emotional advance organizers, capable of connecting curricular content with students' reality and interests, and with pre-designed dynamics and mechanics that aimed toward meaningful activity. Likewise, the moderate correlation between classroom enjoyment and computer use (r = .135, p = .478), although not significant, points to the need to consider the dimension of educational flow proposed by Csikszentmihalyi (1990). Academic enjoyment arises when the challenge and the student's skills are balanced; in the absence of this balance, motivation tends to decrease, regardless of technological mediation. This result underscores that technology, by itself, does not guarantee emotionally stimulating experiences: its motivational potential materializes only when the teacher plans activities that foster self-regulation, cooperation, and a sense of shared challenge.

The longitudinal comparison between 2014 and 2024 reveals a conceptual and motivational transition that can be explained in light of self-determination theory (Deci & Ryan, 2000). While in 2014 students' responses were mediated by technological novelty and extrinsic reinforcement mechanisms, in the current context motivation is sustained by self-regulation and the search for competence, typical of more stable intrinsic motivation—now accustomed to technological mediation. This evolution also corresponds to the framework of flow theory (Csikszentmihalyi, 1990), where enjoyment and engagement appear when challenge and ability are balanced within well-designed digital environments. In this way, the empirical results describe not only a change in students' perception, but also a structural reconfiguration of academic motivation in relation to ICT, consistent with contemporary models of meaningful and emotionally sustained learning.

From a methodological perspective, this study provides a replicable model of ICT integration in primary education, in which technology acts as a pedagogical and emotional mediator, but not as an end in itself. The incorporation of a gamified interactive digital object constitutes a relevant contribution to the field of techno-pedagogical didactics, demonstrating that the combination of digital resources, immediate feedback, and playful narrative can foster more autonomous, sustained, and meaningful student engagement. Theoretically, the study contributes to consolidating the concept of affective digital literacy, understood as the development of teacher and student competencies to design, integrate, and evaluate digital experiences that activate intrinsic motivation and positive learning emotions. This approach broadens the understanding of ICT's impact, proposing a conceptual synthesis between self-determination theory, flow theory, and the principles of meaningful learning as a basis for designing educational digital environments.

In this sense, motivation and engagement depend more on the teaching methodology than on the technological resource itself. Whereas a decade ago the incorporation of ICT generated excitement due to its novelty, the current results suggest that their effectiveness

depends not only on their presence but on how they are used within a well-structured pedagogical framework. In this regard, this study reinforces the idea that motivation is not generated solely by resources, but by the pedagogical approach accompanying them. Strategies such as gamification and Game-Based Learning (GBL) have proven essential for enhancing the impact of technology in the classroom, not only for their ability to generate enthusiasm, but for their capacity to create dynamic learning experiences aligned with students' interests. This finding aligns with previous studies that highlight how combining ICT with active pedagogical approaches can maximize their effectiveness (Janous et al., 2022; Muñoz-Millet, 2023).

At the pedagogical level, this study highlights that the effectiveness of ICT in the classroom can no longer be based solely on their novelty or their isolated presence, but on how they are integrated into instructional strategies that foster autonomy, emotional engagement, and interaction among students. Despite advances, the relationship between ICT and learning remains a dynamic and multifactorial field of study, with variables such as individual preferences, familiarity with digital resources, and application context influencing the perception of ICT usefulness and its impact on learning.

In conclusion, this study shows that the role of ICT in teaching has evolved, shifting from being a factor that alone generated motivation to becoming a resource whose impact largely depends on its articulation with active methodologies. Technology remains a key tool in the teaching–learning process, but its true potential lies in how it is used to enrich the educational experience and foster meaningful learning in students. However, this study demonstrates that ICT effectiveness no longer rests on their mere presence, but on how teachers strategically integrate them to create dynamic, meaningful, and emotionally engaging learning environments. The teacher's role as a designer of learning experiences and pedagogical mediator, using ICT and active methodologies such as gamification and GBL, is essential to maximize educational impact.

Therefore, future research should deepen the optimization of ICT integration in educational practice, evaluating not only the digital tools themselves, but also the pedagogical and emotional design that underpins them. It is not enough to introduce technology in the classroom: it is essential that ICT be conceived as vehicles for intrinsic motivation and sustained engagement, capable of connecting with students' real experiences, interests, and needs. Along these lines, it is essential that digital resources be designed in ways that foster cognitive and emotional engagement, generating learning environments where active participation arises from enjoyment, autonomy, and a sense of competence. As proposed by self-determination theory (Deci & Ryan, 2000) and confirmed by contemporary educational psychology (Pekrun, 2017), the true impact of ICT depends on their ability to create emotionally meaningful learning experiences that transform the student's relationship with knowledge and lead to stimulating, lasting, and truly transformative learning. Overall, the findings and contributions of this study consolidate an emerging line of research that connects emotional education with technological innovation, positioning this work as a reference for understanding and designing educational practices centered on digital motivation and student well-being.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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How to cite:

Ábalos-Aguilera, F.; Hueso-Romero, J. & Romero-Rodríguez, L.M. (2026). Impact of ICT on Motivation and Learning in Primary Education: Towards an exciting school [Impacto de las TIC en la motivación y el aprendizaje en educación primaria: Hacia una escuela emocionante]. *Pixel-Bit, Revista de Medios y Educación*, 75, Art. 1. https://doi.org/10.12795/pixelbit.114450