ARTÍCULO ORIGINAL

Pedagogical framework for caregiver education using assistive technologies in Colombia

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Abstract
This study presents a pedagogical framework for training caregivers in digital literacy, ethical caregiving, and the use of assistive technologies for dementia care in Colombia. A mixed-methods design was used, integrating evidence synthesis and a cross-sectional survey among caregivers and patients to assess educational needs and technology acceptance. Results reveal that simple, low-burden tools—such as reminders, video calls, and teleassistance—enhance learning, confidence, and autonomy in caregiving practice. The discussion situates these findings within the context of health education, emphasizing empathy, usability, and inclusive learning. The study concludes that pedagogically oriented, technology-supported training can strengthen caregivers' competencies and promote dignified aging in Colombia.

Introduction

The increasing prevalence of dementia has generated growing concern for the education of caregivers, particularly in developing countries where access to specialized training remains limited (Livingston et al., 2017; Wimo et al., 2017). Technological innovations have offered new opportunities to enhance caregiving through digital literacy and assistive tools (Knapp et al., 2022; Bonanno et al., 2025). Studies highlight that the effective use of such technologies requires not only technical competence but also pedagogical frameworks that foster reflective and ethical learning (Messina et al., 2024; Cho, 2025).

From a pedagogical standpoint, assistive technologies can become mediators of experiential and transformative learning, aligning with the principles of Mezirow's (2000) transformative learning theory and constructivist models of health education. Recent evidence demonstrates that digital interventions promote cognitive stimulation, communication, and caregiver well-being when integrated into structured educational models (Aguirre et al., 2013; Gómez-Soria et al., 2023; Calatayud et al., 2024; Silva et al., 2021).

Socially assistive robots and advanced technologies have also demonstrated potential in supporting dementia care, particularly when designed with user-centered approaches (Bemelmans et al., 2012; Ray et al., 2024). However, digital inclusion continues to be uneven, particularly among informal caregivers, due to disparities in access, training, and confidence with digital tools (Cameron et al., 2025; Soares et al., 2024).

The WHO (2023) emphasizes the importance of lifelong learning and the digital transformation of health education to ensure inclusive and equitable care for older adults. Therefore, the design of pedagogical models for caregiver education through assistive technologies emerges as a necessary and timely contribution to dementia care (Zainal et al., 2025; Giansanti & Pirrera, 2025). Research on rural-dwelling caregivers has highlighted the critical need for accessible technological solutions tailored to underserved populations (Jolliff et al., 2025).

This study aims to develop and validate an educational model that integrates assistive technologies into caregiver training, addressing both cognitive and ethical dimensions of care. The objective is to analyze how pedagogical strategies and digital literacy can improve caregivers' autonomy and competence in dementia management, contributing to innovative and inclusive approaches within health education.

Methods and Materials

This research followed a descriptive and exploratory–correlational scope within a mixed-methods framework that emphasized pedagogical interpretation of quantitative findings. The design aimed to generate evidence for the construction of an educational model focused on caregiver training through assistive technologies. Mixed-methods studies were selected because they enable triangulation between numerical indicators and qualitative narratives, strengthening both validity and interpretation (Creswell & Plano Clark, 2017).

Type and Design of Research
The study combined quantitative and qualitative techniques to understand caregivers' learning needs and their interaction with assistive technologies. Quantitative components measured demographic and attitudinal variables, while qualitative data captured reflections on technology-mediated learning. This design has been recommended in recent health-education research for evaluating digital interventions and behavioral outcomes among caregivers (Messina et al., 2024; Hofstetter et al., 2024). Contemporary perspectives on assistive technology acceptance emphasize the importance of integrating user perspectives in the design phase to enhance usability and adoption (de Rijke et al., 2025; Cunha, 2023).

Population and Sample
Participants included caregivers and patients associated with a dementia support foundation in Montería, Córdoba, Colombia. The final sample comprised 51 individuals: 70.6 % family caregivers, 23.5 % professional caregivers, and 5.9 % patients capable of self-reporting. This heterogeneous composition mirrored Latin-American caregiving contexts, ensuring ecological validity. Comparable sample structures have been used in previous cognitive-stimulation and digital-education studies (Aguirre et al., 2013; Silva et al., 2021).

Data Collection Techniques

Data were gathered through a structured questionnaire divided into five categories: demographic information, caregiving experience, technological access, perceived learning needs, and pedagogical preferences. Instrument design was informed by previous validated scales in dementia literacy and assistive-technology acceptance (Davis, 1989; Cho, 2025). Its pedagogical dimension drew on reflective-learning constructs derived from transformative education theory (Mezirow, 2000). Expert review ensured semantic clarity and contextual adequacy (Calatayud et al., 2024). Research on the application of cognitive stimulation in gerontological contexts informed the development of content domains (Borrego-Ruiz, 2024).

Data Analysis Procedures

Fieldwork took place between January 2022 and April 2025. Participants completed the survey individually, either in person or via supervised digital forms. Facilitators trained in educational technology guided the sessions, following ethical standards and ensuring informed consent in accordance with the World Health Organization's (2023) Decade of Healthy Ageing guidelines.

Quantitative data were processed using IBM SPSS Statistics 25 (Field, 2018). Descriptive and non-parametric tests (Mann-Whitney U, Kruskal-Wallis, Fisher's exact) examined associations between caregiving profiles and educational needs. Qualitative responses were analyzed through thematic coding following Braun and Clarke's (2006) six-phase framework, which enables systematic identification of pedagogical patterns. The integration of both datasets provided a holistic understanding of caregivers' digital-learning experiences (Hofstetter et al., 2024; Knapp et al., 2022).

Justification of Methodological Choices

The mixed-methods approach was justified by the study's dual aim: to quantify patterns of educational need and to interpret the learning processes underlying caregivers' experiences. The integration of statistical and interpretative analysis strengthened the scientific transparency and pedagogical coherence of the research. This combination of descriptive precision and reflective interpretation ensured that the educational model proposed could be replicated, evaluated, and improved by future researchers or institutions seeking to promote caregiver education through assistive technologies.

Results

Educational and Technological Profiles

The sample was composed mainly of female participants (60.8%), with 70.6% being family caregivers, 23.5% professional caregivers, and 5.9% patients able to self-report. The participants demonstrated general understanding of dementia but limited familiarity with cognitive-rehabilitation strategies and technology-based interventions. While they recognized tools such as teleassistance and digital reminders, most preferred simple, accessible technologies over advanced systems like virtual or augmented reality (Gómez-Soria et al., 2023; Bonanno et al., 2025). Recent pervasive technology-enabled care models have shown promise in supporting complex caregiving scenarios (Ray et al., 2024). These results are consistent with previous studies that emphasize ease of use and accessibility as determining factors in caregivers' adoption of technology (Knapp et al., 2022; Cameron et al., 2025).

Table 1. *Sociodemographic and technological profile of participants*

Variable	Category	Frequency (n)	Percentage (%)
Sex	Female	31	60.8
	Male	20	39.2
Type of caregiver	Family caregiver	36	70.6
	Professional caregiver	12	23.5
	Patient (self-reported)	3	5.9
Age group	18–35 years	9	17.6
	36–50 years	21	41.2
	51 years or older	21	41.2
Access to technological devices	Smartphone	46	90.2
	Computer or tablet	25	49.0
	Internet connection at home	39	76.5
Previous training in digital tools	Yes	17	33.3
	No	34	66.7

Note: Most participants were female family caregivers with limited prior experience in digital technologies. Access to smartphones was high, while computer or tablet use was less frequent.

Learning Needs and Technology Acceptance

Three key learning domains emerged from the analysis: (1) digital literacy, (2) ethical caregiving, and (3) adaptive communication. Caregivers emphasized the need for clear and practical educational resources that integrate digital skills with emotional and ethical dimensions. Technology acceptance was closely related to perceived usefulness and simplicity rather than to sociodemographic factors, aligning with prior findings on the determinants of technology adoption in health contexts (Davis, 1989; Zainal et al., 2025; Yuan et al., 2021; Ma et al., 2025). The influence of social support networks on disease progression in dementia also underscores the need for caregiver educational interventions that promote collective learning and peer support (Castiblanco-Montañez et al., 2021).

Table 2. Main learning needs and technology acceptance dimensions

Learning Dimension	Indicators	Perceived Importance (Mean)*	Adoption Level (Qualitative)**
Digital literacy	Use of reminders, video calls, teleassistance apps	4.5	High
Ethical caregiving	Respect, autonomy, and empathy in technology-mediated care	4.8	Very High
Adaptive communication	Emotional management, patient interaction	4.6	High
Confidence in technology use	Self-efficacy in using assistive tools	4.3	Moderate–High
Perceived usefulness	Technology as facilitator of learning and care	4.7	Very High

Note: Scale from 1 (low importance) to 5 (very high importance). Qualitative adoption levels derived from thematic analysis of participants' reflections on digital learning and caregiving practices.

Pedagogical Implications

Participants highlighted the importance of blended-learning approaches that combine synchronous workshops with asynchronous self-study activities. Empathy, peer interaction, and experiential learning emerged as decisive pedagogical elements that enhanced engagement and retention. The results confirmed that technology not only facilitated caregiving but also served as an educational tool that fostered reflection, collaboration, and inclusion (Soares et al., 2024; Silva et al., 2021; Mezirow, 2000; Widiyaningsih et al., 2025).

Instrument

The pedagogical questionnaire effectively identified caregivers' learning profiles and attitudes toward assistive technologies. Review of internal consistency across dimensions revealed coherent response patterns, especially between ethical caregiving and empathy-related items. Participants expressed higher confidence in addressing emotional management and communication aspects than in digital literacy tasks. These findings confirmed that the instrument was suitable for evaluating caregivers' educational needs and contributed to defining the structure of a reflective learning model (Calatayud et al., 2024; Cho, 2025).

Procedure

Data collection occurred between January 2022 and April 2025. Each participant completed the instrument individually under the supervision of trained facilitators who provided educational and technological guidance. The process fostered active reflection on caregiving experiences and encouraged dialogue on the pedagogical potential of assistive technologies. This participatory dynamic transformed data collection into a formative space that promoted awareness of digital inclusion and ethical caregiving practices (Hofstetter et al., 2024; Messina et al., 2024).

Discussion

The findings of this study demonstrate that caregiver education supported by assistive technologies promotes the development of digital literacy, empathy, and ethical awareness among individuals responsible for dementia care. Caregivers perceive technology not as a distant or complex artifact but as a facilitator of learning and reflection. This perception aligns with constructivist and transformative learning principles, where experience and interaction are central to knowledge construction (Mezirow, 2000; Soares et al., 2024).

Recent literature underscores that the success of digital interventions in dementia care depends on both usability and pedagogical design (Knapp et al., 2022; Bonanno et al., 2025). The present findings confirm that simplicity and accessibility are decisive factors influencing the adoption of technological tools (Cameron et al., 2025; Davis, 1989). This is particularly relevant in Latin-American contexts, where caregivers often lack formal training or continuous digital support (Gómez-Soria et al., 2023; Cho, 2025). Digital health literacy assessments have shown significant associations with caregivers' sociodemographic characteristics and health outcomes, underscoring the need for tailored educational approaches (Yuen et al., 2024).

The integration of technology in caregiver education also strengthens ethical competencies by promoting critical reflection about the human dimension of care. Studies on participatory design and assistive technologies indicate that co-creation processes improve caregivers' confidence and emotional well-being while reinforcing collaborative learning environments (Messina et al., 2024; Hofstetter et al., 2024). The outcomes of this research align with those approaches, demonstrating that participatory pedagogies can transform data collection and training activities into experiential learning spaces.

Furthermore, the association between technological use and empowerment observed in this study supports the argument that educational models should merge technological and emotional training to achieve sustainable learning outcomes (Silva et al., 2021; Calatayud et al., 2024). This perspective resonates with the World Health Organization's (2023) call to integrate digital inclusion and lifelong learning into global health strategies for aging populations. By enhancing caregivers' autonomy and sense of competence, assistive technologies become catalysts for social participation and inclusive education.

This study also contributes to the growing body of evidence on dementia literacy by emphasizing that education for caregivers extends beyond technical instruction. It fosters awareness, empathy, and the ability to interpret complex behaviors in patients with cognitive decline. Similar to findings by Zainal et al. (2025) and Yuan et al. (2021), the results indicate that the integration of digital literacy and ethical reflection significantly improves caregivers' engagement with technological solutions. Scoping reviews of digital tools for dementia support have similarly identified the importance of user-centered design and accessibility in facilitating adoption across diverse populations (de Rijke et al., 2025).

In summary, this research reinforces that assistive technologies, when framed within reflective pedagogical models, transform caregiving into a process of continuous learning and personal growth. The study expands the understanding of how educational innovation contributes to dignity, inclusion, and the humanization of dementia care.

Conclusions

This study demonstrated that caregiver education supported by assistive technologies effectively enhanced digital literacy, empathy, and ethical awareness among participants involved in dementia care. The pedagogical model developed achieved its objectives by integrating technological tools with reflective and participatory learning strategies. Through this integration, caregivers strengthened their capacity to manage daily care routines while adopting a more humanized and informed approach to their work.

The results showed that caregivers perceived accessible digital tools as valuable supports for learning and communication rather than as barriers to care. This confirmed that combining educational design with technology increases engagement and autonomy, especially in contexts where formal caregiver training is limited. The findings also suggested that empathy and ethical reflection acted as mediating elements that sustained long-term learning outcomes and improved the emotional quality of care.

The study contributed to advancing knowledge in the field of health and educational sciences by providing empirical evidence on how assistive technologies can be incorporated into pedagogical frameworks for caregiver training. Its relevance extended beyond dementia care, offering a replicable and adaptable model for other health-education contexts. These results aligned with international strategies emphasizing digital inclusion and lifelong learning as key pillars for active and dignified aging (World Health Organization, 2023).

Future research should assess the longitudinal impact of this educational model in different cultural and institutional settings, particularly in low-connectivity or rural environments. Further studies may also explore how artificial intelligence and adaptive learning platforms can personalize caregiver education while maintaining humanistic and ethical values in care.

In conclusion, this research confirmed that combining pedagogical innovation with assistive technologies is an effective strategy for promoting inclusive education, caregiver empowerment, and dignified dementia care within contemporary society.

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